A STUDY OF THE FE'I BANANA AND ITS DISTRIBUTION WITH REFERENCE TO POLYNESIAN MIGRATIONS

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BERNICE P. BISHOP MUSEUM

BULLETIN 190

HONOLULU, HAWAII

PUBLISHED BY THE MUSEUM

1947

ISSUED MAY 1, 1947

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INTRODUCTION

The distribution of a plant may be recognized as a valid indication of the migrations of a people that uses it as a staple food. Evidence gained from a study of such distribution is valuable if the plant has been carried into regions where it is not indigenous, particularly if the varieties of the species that are most used for food are propagated vegetatively by large plant parts rather than by seeds. Under these circumstances the possibility of distribution by natural agencies is greatly reduced, as the propagation material cannot usually be so carried. Among the food plants of the Polynesians, especially significant is a knowledge of the distribution of the varieties of native bananas propagated only by suckers and chunks or bits of the fleshy corms, the breadfruit propagated only by cuttings, and the taro propagated by corms.

Although all of these food plants were used by nearly all branches of the Polynesian race, except the Maoris of non-tropical New Zealand, certain plants grew better in one island group than in others and became the staple food. This was true of taro in the Hawaiian Islands; breadfruit in the Marquesas and in the Society Islands, to a slightly lesser degree; and the fe'i banana in the Society Islands (12, vol. 1, pp. 59-60)[1]. Bananas of the common species, *Musa sapientum* Linnaeus, were also widely used by Polynesians living in the tropics. The yam, a staple food in Fiji and elsewhere in Melanesia, does not offer so good a subject for distribution study, since it is used relatively little in the eastern islands. The coconut, which undoubtedly was widely dispersed by the Polynesians, was probably also disseminated by ocean currents.

SCOPE OF PROBLEM

As originally planned, this study was to include the distribution of the varieties and types of the common banana, *M. sapientum* Linnaeus, so-called native forms of which are abundant in the forests of the Hawaiian Islands. As no seeded forms of this banana are found in Hawaii, these must have been brought by the Polynesians or another race in their migrations, probably from the Marquesas and the Society Islands to the south. A study of the native forms introduced before the discovery of the Hawaiian Islands by Captain

[1] Numbers in parentheses refer to Literature Cited, p. 53.

Cook has already been made by Higgins (16), MacCaughey (21), and later by Pope (29).

The varieties of bananas introduced by the Hawaiians before the discovery of the islands by Cook in 1778 have been variously recorded. Pope (29), referring to an old manuscript, reports that the older Hawaiians recognized 70 varieties of banana in the Kona district of the island of Hawaii, but there is only about a third of this number on the islands at present. Pope (29), including Higgins' list, gives names of 23 varieties. Five of these he had not seen personally, but he had well authenticated accounts of their presence. This number may be correct for the varieties in the Hawaiian Islands at the present time.

After an attempt to become familiar with the forms of *M. sapientum* on Oahu and Hawaii, it was evident to me that there was not time adequately to complete the study. Although some of the varieties could be found in native gardens and in the forest, many were in the heads of valleys where conditions of abundant moisture and absence of wind obtained. Some types, particularly the variety *iholena,* were common in many valleys; other, rarer, types were not found at all. As a matter of expediency, therefore, the emphasis of the study was changed to the forms of the fe'i banana with the intention of gaining information about the others as time and opportunity permitted. This report is concerned only with the fe'i banana, and the information gathered on the forms of *M. sapientum* is to be published in another paper.

The fe'i banana, known as *borabora,* or its Hawaiian derivative *polapola* (16, p. 45), was supposedly imported to Hawaii in the early nineteenth century (29, p. 29). It is a striking plant easily distinguished from forms of *M. sapientum* by its upright inflorescence and bunch of fruit, as compared with a pendent bunch on a recurved rachis; by the bright violet juice, or sap, which exudes freely from the cut stalks, as contrasted with the milky or nearly clear juice of the common banana; and by the shiny green bracts of the inflorescence, as compared with the red, maroon, or other highly colored bracts of *M. sapientum.* Minor characters are the copper-red color of the ripe fruit and, in most varieties, the short rachis extending very little beyond the pistillate flowers instead of the long pendent rachis extending beyond the bunch for several feet in the common banana.

I covered the islands of Oahu, Hawaii, and Kauai fairly thoroughly. Not all valleys were visited, but an attempt was made to follow up reports of the occurrence of the fe'i banana in order to get photographs and collections. After some weeks of exploration in the Hawaiian Islands, I made a trip to the south Pacific, visiting Fiji, Tonga, Samoa, Rarotonga, and Tahiti. In Tahiti, where the fe'i banana apparently attains its greatest differentiation of varieties, nine weeks were spent in collecting varieties of fe'i and studying the plant in its habitat.

EARLY ACCOUNTS OF THE FE'I BANANA IN TAHITI

A search through the accounts of the voyages of discovery in the Society Islands reveals little specific information regarding the fe'i banana of Tahiti, but it is certain that fruit of this species was bartered for nails, hatchets, and other goods offered by the voyagers in exchange for fresh food. In the accounts of Wallis (45, pp. 252-256), Cook (8, p. 89), and others, bananas and plantains were always among the important fresh supplies obtained at Tahiti, the term plantain probably referring to all banana-like fruits that needed to be cooked before eating. Wallis (45), discoverer of Tahiti, made a trip into the mountains and must have seen the fe'i banana. If he noticed its distinctive habit of growth, however, he failed to mention it. Sir Joseph Banks (3, pp. 102-107) records a trip up the valley inland from Point Venus in which quantities of "Vae", or wild plantain trees, were seen. About six miles up the valley, according to his account, clumps of "Vae" were abundant upon the precipitous slopes. The paths to these clumps were very steep and the worst places had to be spanned by long ropes of hibiscus bark. He states that the wild plantains were used mostly when breadfruits were scarce. Apparently, he did not think the upright inflorescence of the species remarkable.

Banks and Solander observed 28 kinds of bananas and plantains in Tahiti, five of which, according to Solander (40, p. 344), were called collectively fe'i by the natives.

The Forsters, naturalists with Cook on his second voyage, mentioned the abundance of plantains (36); but, according to G. Forster (13, pp. 28-30), they considered them to be forms of *M. paradisiaca* Linnaeus.

Ellis (12, vol. 1, pp. 59-60) states that the natives of the Society Islands cultivated not fewer than 30 varieties of bananas and plantains "besides nearly twenty kinds very large and serviceable that grow wild in the mountains." He refers to the native name fe'i and remarks on the plant's singular habit of bearing the fruit cluster erect. He states that in several of the islands the fe'i is the principal support of the inhabitants.

Charles Darwin (11, pp. 408-413) stopped at Tahiti in 1835 during his voyage around the world. On a trip up the valley of Teaauru above Point Venus he found forests of wild bananas, many plants 20 to 25 feet high and 3 to 4 feet in circumference. The shelter where the party spent the night was thatched with fe'i leaves, just as such shelters are today. Darwin says (11, p. 411), "I could not look upon the surrounding plants without admiration. On every side were forests of bananas, the fruit of which, though serving for food in various ways lay in heaps upon the ground." Moseley (26, p. 517), in about 1875, visited Fautaua Valley, where fe'i bananas were abundant.

Probably one of the most authentic accounts of the varieties of fe'i is that published by Teuira Henry (14, pp. 34-35), but it was not available at the time I was collecting. Miss Henry gives the names of 18 varieties and forms

of the fe'i banana, without descriptions. Of these, 11 were located in my collecting, along with four additional ones. It is probable that some of the names given by Henry are synonyms of some of the additional four, which do not correspond with any in her list. It is possible also that some of the older varieties of fe'i have been lost or destroyed. Fe'i hunters claim that the variety *aoha* is no longer on Tahiti but can still be found on Huahine. On the other hand, it is recognized that one variety may have several names applied to it in different valleys. Probably if there were opportunities to search all the islands of the Society group thoroughly, other varieties and forms could be found. In this study, all important varieties known by local guides and fe'i hunters to occur on Tahiti were located. They include those given by Setchell (38), who gives the names and brief descriptions of varieties as reported by J. Frank Stimson and others. Apparently he did not observe many of the varieties personally.

The relative abundance of the fe'i and the forms of the common banana (*Musa sapientum*) in the Tahitian bush is in sharp contrast to that found in the Hawaiian Islands. In Hawaii, forms of the common banana were frequent, growing wild in nearly all moist valleys, whereas fe'i was relatively rare. In Tahiti, for the most part, the common banana was to be found in gardens. Only once were wild plants observed in the bush, in the valley of Papenoo. Fe'i, on the other hand, was in great abundance in the many valleys suited to its growth, except where it had disappeared (pp. 8-9).

USES OF FE'I

The fe'i banana is still the staple carbohydrate food of the native Society Islanders, though breadfruit, taro, and sweet potatoes are eaten. With other types of banana, fe'i is given first place by Henry (14, p. 33), and Cuzent (9) also gave it first place in 1857. At the time of my study (1927), the fe'i was more abundant in the native markets (pl. 2, *B*) than any other foodstuff. No more than five percent of all bananas found on the market were of the *Musa sapientum* type. In the villages near which fe'i is obtainable, the men and older boys go into the valleys every Saturday for the week's supply. They leave early in the morning, returning in the late forenoon or early afternoon laden with bunches of fruit swung on the ends of a pole carried across the shoulders or back of the neck (pl. 1, *B, C*). Such expeditions were observed by Wallis (45), Darwin (11), and Moseley (26). The bunches are hung in the dooryard of the native houses.

Fe'i must be cooked, as the ripe raw fruit has a biting, astringent flavor and the green fruit is quite unpalatable. It is best suited for food when it is ripe but still firm. Formerly it was roasted in a pit with other food, but now the fruit is boiled in five gallon kerosene tins. The boiled fruit is pinched or rolled between the hands until the skin is readily removed. Dipping it in sea water to

supply salt adds to the palatability. So prepared, the fruit in this stage is not sweet. The riper fruit is used less often but is sometimes prepared as a pudding. The sweet pulp of the variety *'afara,* considered of the highest quality, is sometimes cooked and fed to infants at the time of weaning.

The food value and a comparison of the composition of the green and ripe fruit is given in the following analyses (table 1) made by L. J. Cross, Chief Analytical Chemist of the State of New York. These analyses show the high total food value of the fe'i and also the high starch content of the green fruit which changes to sugar as it ripens.

Table 1

Analysis of Dried Fe'i

	Green Fruit percent	Ripe Fruit percent
Water	7.76	7.54
Fat	1.45	1.40
Protein	2.90	3.15
Carbohydrates	84.80	84.97
Ash	3.09	2.94

Analysis of Carbohydrate Content

	percent	percent
Starch	51.90	38.47
Sucrose	21.60	31.20
Reducing sugars	11.30	15.30

The proportion of peeling in the ripe firm fruit is about one third; in general the larger the fruit the thinner the peeling proportionally. The variety *'aiuri* from Manoa Valley on Oahu showed 31.3 percent peeling for the larger fruit and 35.6 percent for the smaller, with the average of three determinations 32.9 percent. The percentage of dry matter in the peeled pulp of these same fruits was 27.2 percent in one sample and 25.6 percent in another. The proportion of peeling probably varies considerably in different varieties but the dry matter is somewhat more constant.

The fe'i plant has many uses. The edges of the midrib of the leaf contain long fibers, which can be stripped off easily and used as a stout thong. The fe'i carrier uses it to bind bunches of fruit to the ends of the carrying pole. The fiber of the leaves and midribs is cleaned from the pulp and used in making artificial flowers and fringes. Freshly cut trunks of the plants are very buoyant and are used as rafts in crossing inland streams or lakes. At Lake Vaihiria, the native guides cut five trunks into sections, pegged them together with green sticks for dowels, and made a raft that would support a man. Two trunks made a raft upon which one native placed his clothes and a small dog. Using the raft as a float, he swam with it across the lake.

The broad, smooth green leaves are often used as plates or trays for cooked food. For a native meal, several large leaves are laid out to make a "tablecloth" and each person has his own leaf plate. The green leaves, with blades about 2 by 8 feet, or sometimes as much as 2.5 by 10 feet, are used to cover temporary shelters made in the forest. Lean-to shelters are constructed of poles, bamboo if obtainable, and the roof shingled over with banana leaves. Such a hut sheltered Darwin (11) when he visited Tahiti in 1835, and similar shelters are used today.

The leaf blades of the lower leaves, which become brown, pliable, and dry, as they hang from the older plants in the forest, are used as waterproof wrappings for such small objects as matches and tobacco. Small pieces of the thinner parts of the dried leaf are used as cigarette papers, the Tahitians apparently preferring them to the prepared rice papers. These dried leaves, which can be collected in quantity in many localities, make excellent padding upon which to sleep and also good fuel with which to start a fire. The hard, fibrous outside layer of the sheathing leaf bases or trunk is black and shining. It is split into narrow strips and dried, and the strips are used in the plaiting of fans and mats.

The mushy ripe pulp of the variety *'afara* was formerly used in early stages of elephantiasis as a poultice to place over the inflamed area. The hot pulp was also used to poultice boils and similar eruptions. J. C. Hamel reports (personal letter) that in the Moluccas the plant was used as a laxative, to treat kidney trouble, and to quiet fevers.

The violet-colored juice of the trunks dyes black with no special preparation, and the fresh sap may be used as a substitute for indelible ink. Mixed with the juice of the fruit of the *mati* (*Ficus tinctoria* Forster), a red hue is produced. Cuzent (9) tried the sap of the fe'i banana with many reagents and obtained dyestuffs in all shades of red, blue, lilac, yellow, and green. In his opinion the material might be used in industry, but this apparently has not been done, doubtless because of the availability of more readily manufactured dyestuffs.

DISAPPEARANCE OF FE'I FROM SOME VALLEYS

The present distribution of the wild fe'i in Tahiti is more restricted than in earlier times. Tahitians report that the fe'i was abundant in the great valley of Papenoo in former years. Now there is practically none. At least, an eight-days' trip into the valley failed to reveal more than a few scrubby plants. Not all of the valley was explored, but it is significant that the natives no longer regard this valley as a source of fe'i. Darwin, as quoted earlier (11, p. 411), found quantities of fe'i in the valley above Point Venus, where it is not so abundant now. On the cliff (*pari*) on the windward side of the Taiarapu Peninsula, according to Tahitians, the fe'i could formerly be seen from the

shore in abundance. At present, there are but a few plants visible along the shore and these are having a hard struggle with encroaching plants, particularly a wild, creeping morning-glory [probably *Ipomoea pes-caprae* (Linnaeus) Sweet].

Among the more important causes of the disappearance of the fe'i is the devastation wrought by wild cattle and hogs. Where these animals are abundant, all the vegetation suffers, especially the banana plants which are eaten by them.

Another contributing cause is the introduction of plants that overrun the native vegetation. One of the most obnoxious of these is lantana, which, though apparently not so abundant or troublesome as it is in the Hawaiian Islands, is a menace to native vegetation at lower altitudes. The giant morning-glory in many places, particularly on the windward side of the islands, is smothering the fe'i and other vegetation. This vigorous, rampant climber scrambles all over the plants, binds up the unfolding leaves of the young plants, shades the older ones, and sometimes seems to break them over by sheer weight. It is not so abundant at the higher altitudes, where it is not a destructive factor. Whether or not this plant is indigenous, I am uncertain. The stag-horn fern (*anuhe*), *Gleichenia linearis* (Burmann) Clarke, though abundant in parts of the island, did not compete with fe'i to any great extent, as it was not abundant at the higher altitudes or in the moist habitat where the fe'i grows best. On the abrupt hill rising above Lake Vaihiria, however, the *anuhe* fern is the dominant vegetation. As fe'i flourishes in nearby places not infested with this fern, perhaps the fern had been a factor in the disappearance of the fe'i from the hill.

In some of the valleys, particularly Vairaharaha, the corms and bases of the fe'i plants are infested with the snout beetle, *Cosmopolites sordidus* (Germar), a pest of bananas in many places. To what extent these beetles contribute to the disappearance of fe'i in some valleys is uncertain. It is probable that they are not native to the islands but have been brought with some of the recently introduced plants. I have no evidence on this point, nor was evidence obtained as to the extent of the infestation in the valleys of the island, as the beetle was not discovered until near the end of my stay in Tahiti.

Gathering methods used by the natives are in part responsible for the decline of the wild fe'i. At no time during the nine weeks I spent on Tahiti did I observe any care taken by native hunters to encourage the growth of the fe'i, though a few clips of the machete would have discouraged competing vegetation. Growth was even discouraged, for it was common practice, when cutting down a bunch of fe'i, to slash down not only the stalk bearing the fruit but any young stalks that might be in the way.

CULTIVATION OF FE'I

Some varieties of fe'i were cultivated in the rich flatlands at the mouths of the valleys. One of the most common was *tati'a,* though *'a'ata, paru,* and *ha'a* were also observed. According to informants, other varieties cultivated, but to a lesser extent, are *'afara, oeoe, rureva,* and *poti'a.* It is doubtful whether *poti'a* is cultivated much, as it is of relatively poor eating quality. The plants are apparently easily grown in gardens, where they generally form larger bunches than grow in the mountains. In one plantation in the Vairao district, plants of *tati'a* were exceptionally large, with trunks 25 feet tall and 18 inches through at the base. Under cultivation, the rachis bearing the staminate flowers extending beyond the top of the bunch is commonly much longer in this variety than in the wild plants (pl. 8, *D*). This was true of three mature bunches in cultivation and many in the wild, and all the native guides consulted agreed that this difference was usual. In the character of the extended rachis bearing staminate flowers (pl. 8, *D*), this variety approaches the condition found in *M. sapientum* and suggests that the variety may be a transitional form. Such a variety, with extended rachis bearing persistent bracts, is also reported by Wilder from Rarotonga in the Cook Islands (46, p. 34).

The cultivation of fe'i by the natives is haphazard. Nowhere did I see a plantation of more than a few irregular clumps. Apparently the plants grow easily in rich soil where there is abundant moisture. Propagation is usually by planting the smaller suckers taken from an established clump. Competing weeds and other growth are kept down after a fashion, though plants were observed growing well in the light shade of higher trees. Some clumps were growing well from a ground cover of *Tradescantia,* common on the shaded lowlands. Much more could be done in cultivating fe'i.

FE'I IN THE FORESTS OF TAHITI

In the forests of Tahiti, the fe'i banana is now found to be growing best in moist valleys on the windward side of the island. The best plants are found at altitudes of about 600 to 800 meters, near the heads of the valleys. According to T. Nadeaud and others, fe'i will grow at heights of 1,200 meters but are rarely found at that altitude now. At the higher altitudes the fruit is edible but the pulp is coarse and spongy and not as good as that grown at lower altitudes.

Doubtless in earlier times the plants extended to the lower, more accessible parts of the valleys. However, even the early accounts, that of Sir Joseph Banks (3) for instance, state that the fe'i grew on precipitous slopes of the valleys about six miles up, where the paths followed by the natives were nearly perpendicular. Bank's description applies today.

The fact that the fe'i grows well under cultivation at lower altitudes indicates that its disappearance in the lowlands is probably the result of extermination by man and other agencies and the failure of the plant to compete unaided with introduced species making up the vegetation at the lower altitudes. At higher altitudes and particularly in the more inaccessible valleys, the balance of the native vegetation has not been upset by foreign introductions or by man and the fe'i appears to be a part of the native flora.

The best habitat for the growth of fe'i is on talus slopes at the foot of precipitous cliffs, where there is usually abundant moisture from the cliffs, protection from winds, and well-drained soil. On the ridge separating Vaihiria Valley from Papenoo Valley the finest specimens of fe'i were observed. The massive trunks stood in thick clumps on the steep slope bearing the heaviest bunches I found (pl. 1, *A*). The variety most abundant was ***rureva,*** its bunches so large that two of them balanced on a pole made a full load (pl. 1, *C*). The excellence of these plants is partly due to favorable conditions of soil, moisture, and altitude, and partly to freedom from molestation. The distance up to the lake from the mouth of the valley is about eight miles, and the only way to reach the plants is to swim the lake, a distance of about half a mile. The fe'i there were apparently not collected, or at least rarely, and huge bunches were found rotting on the plants and on the ground.

COLLECTION OF FE'I BY THE TAHITIANS

Although there are many fe'i on the slopes of Vaihiria Valley below the lake and in neighboring valleys, the most typical fe'i valleys are on Taiarapu Peninsula. Here, in the districts of Vairao, Teahupoo, Pueu, and Tautira, the valleys are shorter than on the main part of the island. These districts furnish the largest proportion of the fe'i on the Papeete markets.

The fe'i hunters follow the course of the streams, which may be swollen and offer some difficulty in the rainy season. In many valleys, there is an escarpment to climb to reach the upper levels. Toe holds are sometimes hollowed out of the cliff, *'ie'ie* vines (*Freycinetia* sp.) or, as once observed, heavy steel wires serve as ropes. In former times, strips of *purau* (*Hibiscus tiliaceus* Linnaeus) bark served this purpose. In the upper part of the valleys, the fe'i trails leave the stream and lead up the steep sides, which the natives easily climb. Few of the trails leading up the valley slopes are plainly marked, although many are of long standing, particularly those near the streams, and are often the only way to gain the higher slopes. High on the slopes, where clumps of fe'i are found, there are no trails and the hunter has to cut his way through the dense growth to reach a clump spotted from the trail below.

When the hunter reaches a clump of fe'i with a bunch of mature fruit, he partially clears the space where the bunch is to fall and then nicks the trunk

of the plant with his machete. The cut is made about a third of the way up the trunk from the base and only part way through. Properly cut, the bunch topples over slowly so that it is not jammed or broken. The bunch is then cut free from the stalk with a blow of the knife. The hunter strips a thong from the midrib of one of the leaves of the fallen plant and ties a loop about the stem of the bunch. Sometimes the fruits are padded to prevent bruising, by packing the spaces between them with dried leaves of the fe'i.

When two sufficiently mature bunches are found they are tied, one at each end, to a pole about 5 feet long. This carrying pole, balanced across the shoulders or back of the neck (pl. 1, *B, C*), makes it possible to carry heavy loads a long distance over rough terrain. Some of the loads seen in the Vairao district were made up of six medium-sized bunches; boys 12 to 14 years of age carried four. Although none of the loads were weighed, the large ones were estimated to be between 125 and 150 pounds. On the level trails in the valley, the carrier often goes at a smooth gliding trot, covering the ground rapidly. When he stops to rest, the load is balanced over a rock or log, or sometimes on the top of a tree stub cut off for the purpose and notched with the machete to hold the carrying pole.

Many of these fe'i carriers develop swollen cushions of flesh on their shoulders which in some individuals are connected with a ridge or pad across the back of the neck. They do not seem to be inflamed or sore and are apparently a sort of callus formed in response to continued pressure (pl. 1, *B*). It is reported that ruptures are common in adolescent boys, as a result of carrying loads too heavy for them.

The Vairao district furnished many fe'i for the Papeete market. According to M. Hamblin, *chef* of that district, the four big valleys of the district furnish about 100 bunches per day in the height of the season. The valleys in this district are short, four to six miles long, as compared with the valleys of the Mataiea, Vaihiria, and other districts on the main part of the island of Tahiti. Teriimanu, a guide, reported that in Vairao there is an organization of fe'i hunters made up of about a dozen men who systematize the gathering of fe'i for the market. They cover a different part of one of the valleys each day. Several of these groups of fe'i hunters were observed as they came out of the valley with their loads.

The bunches of firm ripe fruit are transported to the Papeete market on buses that go around the inhabited parts of the island. The fe'i are tied on the outside, sometimes nearly covering the bus (pl. 2, *A*). In the markets they are hung on racks for inspection and sale (pl. 2, *B*). Although there are some fe'i maturing every month of the year, the season with an abundance of fruit begins in January and continues through August. The number of ripening bunches decreases during September, and reaches a minimum in December.

SEED FORMATION IN THE FE'I BANANA

Seed formation in the varieties of fe'i is a question on which there is much difference of opinion. Sagot (33) states that the fe'i bears fruit containing seeds at altitudes of 1,200 meters or more whereas at lower altitudes the fruits are seedless. This statement has been reproduced in a number of publications dealing with the fe'i banana. As a result of a conference held with T. Nadeaud, grandson of the botanist-physician Nadeaud, and *chef* of Hitiaa; Pau Tane, a Tahitian thoroughly versed on fe'i; W. B. Jones, botanist of the Whitney Expedition to the Marquesas; and J. F. Stimson, it was concluded that there are two types of seed habit. Many phases of the fe'i problem, such as native names, uses, and distribution of varieties, were considered at this conference. I am much indebted to these men.

One type of seed habit is more or less definitely fixed, the plants bearing seeds regardless of altitude or other environmental factor. This is probably the primitive type or basic species. T. Nadeaud and others stated that the seeded type existed at high altitudes on the cliffs of some of the valleys of the Taiarapu Peninsula particularly in the valleys of Tautira. However, several weeks' search in the latter part of June and early July failed to locate them. One guide was confident that the seeded form could be found on the talus slope at the foot of the cliffs in the valley of Tii. The fe'i there, however, contained no seeds, and none were found in the valleys of Aiurua, Vaita, and Faaroa. The Tahitians consulted agreed that the true seeded form is rare at present and exists only in inaccessible places. This is true in the other Society Islands and in the Marquesas, where Jones found the seeded form on Fatuhiva. He reported plants bearing the seeded fruits high in the mountains and difficult of access. They were growing near the site of the old breadfruit storage pits that the Marquesans used for a reserve supply in time of war, when they took refuge in the mountains. The plants showed every indication of being part of the native flora. They were short with trunks only about 2 meters high; the bunches were small and the fruit full of apparently well-developed seeds. Specimens were sent to the American Museum of Natural History with other collections from the Whitney Expedition. I later attempted unsuccessfully to locate these specimens in order to examine the seeds for well-developed embryos.

The occurrence of the seeded type in high, inaccessible places may be the foundation of Sagot's theory that seeded forms are to be found only at higher altitudes and that seed bearing is influenced by altitude. This of course may be true as environment undoubtedly has an effect on seeding. Altitude is, however, evidently not the determining factor. It seems more likely that the seeded type is now confined to the less accessible places, because the seeded, almost inedible types, were destroyed in the early days by fe'i hunters. This seeded

form may be the basic species reported as common in the Solomon Islands and the New Hebrides. If this is so, the problem arises as to how the seeded type could become established in inaccessible places in the Society Islands and the Marquesas.

In addition to the primitive form which bears seeded fruits at all times regardless of environmental conditions, seasonal seeded forms occur which bear seeded fruit only under certain conditions. According to the observations of T. Nadeaud which were confirmed by guides and informants, the normally seedless varieties, *'aiuri, 'afara, 'a'ata, tati'a,* and *mahani,* may, under some conditions, bear fruit with seeds. One informant included the variety *rureva* among the seeded forms, but all agreed that the others did not develop seeds. These seeds are called *fe'i iri iri* or sometimes *fe'i ofai.*

The determining factor in seed formation seems to be heat and drought. A hot dry season is favorable for seed production and in such dry years, in some of the valleys, the fruits of these seed-forming varieties are practically inedible toward the end of the fe'i season. In other seasons, the fe'i in the same valleys are free of seeds. Apparently seed formation is not frequent, for since 1927, when I attempted to locate *fe'i iri iri* on the cliffs and elsewhere in Tahiti, Stimson has made repeated attempts to obtain seeded fe'i from the native hunters. Two lots of poorly developed seeds have been procured, and several fruits of the variety *'aiuri* containing seeds have been sent in for examination. As compared with the seeds of other banana species, fe'i seeds are small, irregular, and shrunken, without trace of an embryo (pl. 3, *A*). They occur only occasionally in the pulp, in contrast to the full complement of seeds in the rows of other seeded bananas (pl. 3, *B*). T. Nadeaud stated that his grandfather germinated seeds of the variety *'aiuri* and obtained living plants. So far, attempts to germinate seeds which I collected have failed.

The occurrence of fe'i with viable seeds in the various groups of islands has an important bearing on the question of whether it is indigenous in any one group. All evidence points to the fact that forms capable of bearing viable seeds do occur in Tahiti and the Marquesas. The germination of fe'i seed by the botanist Nadeaud is too well authenticated to ignore, especially in view of the general agreement among native sources that seeded forms do occur. The primitive seeded type in Tahiti, however, still remains to be found and its seeds germinated to make certain of the occurrence of this type at present.

The presence of seeded forms of fe'i in some of the island groups farther west is well authenticated. Reverend F. J. Paton, resident in the New Hebrides, states (personal letter) that seeded forms of the plant are to be found in the forests of those islands, together with seedless forms. The plant is reported as of frequent occurrence in the bush. J. F. Kajewski, a botanist working in the island groups north of Australia, states (personal letter) that

the mountain plantains on Bougainville are of the fe'i type and are all seeded. The most vigorous plants there grow in the mountains at an altitude of about 1,000 meters, but similar forms extend down to the coast.

The relative scarcity of seeded forms in the Society Islands as compared with regions farther west indicates that it has been introduced as clones rather than as a seeded form. The presence of seeded forms in the Society Islands has, of course, an important bearing on the development of the varieties found there.

THE TECHNICAL NAME OF THE FE'I BANANA

To determine the valid technical name for the fe'i banana is a difficult taxonomic problem. Bananas as a group are hard to handle taxonomically because the size of the plants and their succulent nature make the preparation of good herbarium material almost impossible. In critically examining the literature on the genus *Musa,* it is evident that the taxonomic treatments of the genus have been made without adequate herbarium material. Such material should include: pickled staminate and pistillate flowers and fruits that give an indication of the size and form of each; pressed leaf bases, blades, and bracts; notes as to color of bracts and trunk; dimensions of bracts and trunk; color and nature of sap and other outstanding characters of the plants; and, most important, photographs of the growing plants to indicate habit, position of bracts, particularly on the inflorescence, and the nature of the extended rachis.

The taxonomy of the fe'i banana is particularly obscure. The confused synonymy of the plant is difficult to check, because of the lack of type material and because the region where the plant is probably indigenous is little known botanically and sparsely settled by those persons who could be of assistance in tracing its distribution. This applies especially to the region west of Fiji to the Malay Peninsula.

The accepted name of the fe'i banana in Index Kewensis is *Musa Fehi* Bertero, as published by Vieillard (44) in 1861. He states that the plant is native in the mountains of New Caledonia and Tahiti. In Index Kewensis, *M. Uranoscopus* of B. Seemann (36, p. 290) is given as a synonym. Seemann, however, considered the plant growing in Fiji to be the same as that described by Rumphius (32, p. 137) under the same name. There is little question that the Fijian plants which I have seen are the same as those in Tahiti and New Caledonia.

The valid name of the fe'i banana under the Vienna Code depends on whether the *M. Uranoscopos* of Rumphius is the same plant as the *M. Fehi* of Bertero as published by Vieillard. If these are the same, *M. Troglodytarum* Linnaeus is valid, as Linnaeus (20, p. 1478) specifically cites Rumphius' description and name. E. D. Merrill and L. H. Bailey (in personal consultation)

agreed with me that the plants are the same, after examination of the evidence herewith presented. I am indebted to them and to K. M. Wiegand for their suggestions in straightening out the synonymy of the plant. E. D. Merrill (23) states, "I am now convinced that what Rumphius actually had was a form of *Musa Fehi* Bert." More recently, 1938, J. Carel Hamel has furnished a photograph of the banana known as *pisang tonghat langit* (pl. 10, *A*) in Amboina. This was identified with photographs of Tahitian forms of the fe'i banana. He also sent prints of the photographs to various stations in the Moluccas and established the fact that the plant was present on Haroekoe, Saparoea, Boeroe, West Ceram, and Groot Kei. It was reported absent on Banda, Ternate, Poelan Batjan, and the Aru Islands. The absence of the fe'i banana on these nearby islands of the Moluccas, together with Hamel's observation that the plant occurred only in gardens, is strong evidence that it is not indigenous. This is further confirmed by A. Evers, agricultural inspector of the Moluccas stationed at Amboina, who states that the forms growing there have no seeds and that the plants are always in gardens, not wild in the bush. One of Hamel's informants states that the natives of Boeroe are afraid to eat the fruit because it colors the urine red.

From this evidence it is clear that the banana described by Rumphius as *Musa Uranoscopos* is still present in Amboina, growing in much the same condition as he described it. It still remains to compare in greater detail the plants he described with those now found in Polynesia. His description is sufficiently specific to permit such comparison of characters. A translation of Rumphius' description (32, p. 137) from the original Latin and Dutch follows:

Musa Uranoscopos, Pissang Toncat Langit or Tundjo Langit, has a peculiar habit differing from those species before mentioned, as all the other species have nodding or pendent inflorescences while this one is truly erect. The leaves are narrow as they are in our Kockin or *Folii mensarii.*

The fruit is small, not straight, broad above, thick and generally rounded, closely resembling a Chinese trong or cucumber, of a reddish color [might be coppery red], or reddish with dark stripes which terminate above in the broad tip. The flesh inside is yellow, in which are located flattened dark seeds distributed in five or six longitudinal rows. The flesh is mucilaginous and slightly acid but when thoroughly ripe, very sweet with an odor of the woods.

The heart, or Djantong [extended rachis bearing staminate flowers], is longer than in other species of Musa, having at least the length of a foot, not as broad as long nor dark colored as in other species, but green and glabrous throughout. The substance of the trunk and branches is thicker and more solid than in all other species, and of a green color much the same as in species eleven described above.

Name. This unusual species I have called in Latin, *Musa Uranoscopos,* which means heaven bearing, or heaven viewing. Likewise the Malaysian Pissang Tundjoc Langit and Toncat Langit and the Ternatian, Tuca Luffa all mean the same thing. In Ceram it is called Tema Tenalla Lanit which has a similar meaning.

Distribution. It is of rare occurrence and because of its rarity is found only in gardens of collectors, principally in the Moluccas, rarely in Amboina. On the northern coast of Ceram it is likewise found.

Uses. This species is not eaten raw, as it causes itching of the throat, but cooked slowly under the ashes [coals] it tastes sweet, insipid, mucilaginous with a somewhat tough texture. It is sometimes eaten to provoke urination which it does without causing pain. As it colors the urine red, however, it is seldom eaten. The Amboinese natives have a superstition that while they cut the stem they must keep still for if they talk the stem will emit blood, for the exuded sap is as a matter of fact light blood red. In the district of Tanoena the natives eat the fruit without fear, but foreigners hold it in some measure of abhorrence because, as indicated above, it tinges the urine red. The fruit is, however, harmless.

Connection of Rumphius' Species with the Musa Fehi of Bertero

One significant point in the description that identifies the species with *M. Fehi* Bertero is the upright inflorescence, a truly distinctive character, as the other species of *Musa* with erect inflorescence belong, according to Baker (2) in another section of the subgenus, *Rhodochlamys,* with colored bracts. *M. Hillii,* which has colored bracts, is easily separated from *M. Fehi* by its nonstoloniferous habit and inedible fruit.

Rumphius' description of the fruit applies in general to the fruit of *M. Fehi* Bertero as observed in its many variations in Tahiti, with the possible exception of the stripes upon the fruit. The nature of the striping is not clear from Rumphius' description. The stripes of the Tahitian forms are not caused by differences in the pigmentation of the skin, but rather by stains due to weathering and slight cracking of the skin. The presence of seeds in the fruits is not usual in Tahiti, but seeded forms do occur, particularly in forms found in the New Hebrides. As has been discussed (pp. 13-15), a number of varieties may have seeds under some conditions.

The green, glabrous bracts of Rumphius' species comprise one of the most important characteristics in common with *M. Fehi* Bertero and differ from other species which have colored bracts enclosing the flowers. Rumphius' figure of the bunch *M. Uranoscopos* with the extended rachis is typical of some of the forms of *M. Fehi* occurring in Tahiti. Most of the Tahitian forms have a short, extended rachis which remains upright at the maturity of the bunch. However, the variety *tati'a* (pl. 8, *D*), growing at the lower altitudes, has an extended rachis which bends over in the manner shown in Rumphius' figure (32, p. 139).

Rumphius' description of the inedible raw fruit applies equally well to the fe'i of Tahiti. A significant similarity between Rumphius' species and that found in Tahiti is the light red or violet sap which exudes from the plants, particularly when the young trunks are cut. Other species of bananas with which I am familiar have clear or whitish translucent sap.

The statement of Rumphius that eating the fruit colors the urine red is also applicable to the Tahitian species, though the color might better be described as reddish amber.

The above-mentioned similarities between the plant described by Rumphius and the forms in Tahiti now classified as *M. Fehi* Bertero indicate that the plants are of the same species. This is made practically certain by the statements and photographs (pl. 10, *A*) furnished by Hamel. However, there may be technical characters of fruit or flowers not covered in the description that would serve to separate the plants into two species. Rumphius describes the species as occurring only in gardens, which might mean that the plant was not native in Amboina but was brought in from the east. Certainly considerable confusion exists in the literature regarding the relationship between Rumphius' *M. Uranoscopos* and *M. Fehi* Bertero. Much of this confusion is due to the inability, or at least the failure, of those dealing with the taxonomy of the species to consult adequate living or herbarium material, or to check up with Rumphius' original description.

Seemann (36) thought the plants designated by his *M. uranoscopus* were the same as those of Rumphius' species, *M. Uranoscopos*. His opinion should carry weight, for he was familiar not only with the plants in Fiji but had visited Papua and other islands near Rumphius' type locality on the voyage of H.M.S. *Herald*. Unfortunately, no mention is made of the occurrence of *M. Uranoscopos* Rumphius on the islands west of Fiji in the accounts of that voyage (35).

S. Kurz (18, p. 297), writing in 1866, made the following statement regarding Seemann's species: "A fourth species of plantains—which, however, has not come under my inspection—is indigenous all over the Pacific Islands and referred to *M. uranoscopus* [of Rumphius] by Dr. Seemann, but is evidently different." No evidence for this opinion is given. However, F. von Mueller (27, p. 190), on the basis of Kurz' statement, changed Seemann's *M. uranoscopus* to *M. Seemanni* F. von Mueller. This change was recognized in the Gardener's Chronicle (1, p. 182) and followed by both Baker (2) and Schumann (34).

In 1878, Kurz (19, p. 166) wrote concerning *M. Troglodytarum* Linnaeus, the *M. Uranoscopos* of Rumphius: "This species is as yet imperfectly known although it is one of the most cultivated forms of Australasia extending as far west as the Moluccas and the Philippines. It is a very distinct species in habit, much resembling *M. textilis* and as large. The erect spadix and much imbricated bracts alone distinguish it from the rest of the cultivated species of *Musa*. The only figure of this is the one given by Rumphius in his Herbarium Amboinense." The statement that the plant occurs in the Philippines is apparently incorrect, as Merrill is sure that it does not occur there.

Kurz' description follows that of Rumphius in general but is somewhat more detailed in some characters. In commenting on the name he states (19, p. 165): "Thus Linné most unfortunately changed Rhumph's excellent name of *M. uranoscopos* into the very absurd one of *M. troglodytarum* and Colla,

therefore, not without reason, restituted Rhumph's name." Kurz (19, p. 130) says: "According to the late Dr. B. Seemann, there are about 18 different kinds of plantains on the Viti islands, which all have distinct names. They are said to belong chiefly to *Musa uranoscopos,* Rhumph., which bears erect dense bunches of orange coloured fruits." Nowhere in this reference does Kurz state that he considers the *M. uranoscopus* of Seemann and the *M. Uranoscopos* of Rumphius to be different plants. It is evident that Kurz was not familiar with either, and the fact that he does not put them together has little significance.

In the Index Kewensis, *M. Troglodytarum* Kurz is given as a synonym of *M. Fehi* Bertero in part. Kurz (19), however, gives Linnaeus authorship for the name as referring to Rumphius' species. The *M. Fei* Bertero of Nadeaud (28) is obviously a mistake for *M. Fehi* Bertero.

Recent treatments of *Musa* in various publications have not served to clarify the nomenclature. Baker (2) considers *M. Fehi* of Bertero as distinct from *M. Troglodytarum* of Linnaeus, which he makes a variety under *M. sapientum,* together with *M. paradisiaca* and other forms. This treatment is quite inconsistent with his key to the subgenus *Eumusa* which puts *M. Fehi* Bertero into the section with erect inflorescence spikes and *M. Troglodytarum* Linnaeus into that with nodding inflorescences even though Linnaeus' description (20) of *M. Troglodytarum* states that the inflorescence is erect. Baker is evidently not familiar with this plant as he follows Rumphius' description and cites Moon as authority for its occurrence on Ceylon. The synonymy given by Baker is essentially that given in the Index Kewensis.

Schumann (34) follows in general the systematic treatment of Baker with regard to *M. Fehi* Bertero, except that he gives the authorship of the name to Vieillard. This is not tenable, as Vieillard recognized Bertero as the author in his publication of the type description. In a note, Schumann (34) states that it is not certain that any plants of *M. Fehi* Bertero occur outside of Tahiti, an inconsistent statement in view of the fact that the plant was described from New Caledonia.

Schumann makes the *M. Troglodytarum* of Linnaeus, with direct reference to Rumphius' *M. Uranoscopos,* a subspecies under *M. paradisiaca.* As in Baker's treatment, the plant is included in the section of the genus with a pendent inflorescence, though the description of the plant states that the inflorescence is erect.

Setchell (38) states that *M. Uranoscopos* of Rumphius and *M. Troglodytarum* of Linnaeus are referable to *M. uranoscopus* Loureiro. This, however, is a synonym of *M. coccinea* Andrews, as indicated by Kurz (19, p. 165) and Schumann (34) and as confirmed in conversation with E. D. Merrill.

M. Troglodytarum Linnaeus is an elusive plant, about which little is known from the region west of Papua. Moon (25) lists four varieties under the spe-

cies, one of which was supposed to be growing wild in Ceylon. He gives no indication that he ever had first-hand contact with the plant. This reference occurs repeatedly in later work. Trimen (42, vol. 4, p. 266) cites Moon's reference to *M. Troglodytarum* Linnaeus but states that he has seen in Ceylon no banana with an upright florescence. The botanist of the Department of Agriculture in Ceylon reported (1927, personal letter) that he had not been able to get *M. Troglodytarum,* and the head of the herbarium at the Botanical Garden at Buitzenzorg wrote (1927, personal letter) that he was unable to give an opinion about it as he had never seen material of this form. It is obviously doubtful whether *M. Troglodytarum* occurs in Ceylon or on the mainland of Asia.

Miquel (24) follows Rumphius in giving Linnaeus' name as a synonym. The brief description is obviously taken from Rumphius. Heyne (15) follows Rumphius throughout in his description; he does, however, state that there is material of *M. Uranoscopos* Rumphius in the museum at Buitzenzorg, a statement which does not check with the inquiry made in 1927.

Synonymy

Musa Troglodytarum Linnaeus, Sp. Pl., ed. **2**: 1478, 1763 (printed as *Troglodylarum,* corrected in ed. 3 to *Troglodytarum*).

Musa Uranoscopos Rumphius, Herb. Amb. **5**: 137, pl. 61, fig. 2, 1747.

Musa Uranoscopus Colla, Memoria Accad. Torino **25**: 387-388, 1820.

Musa Fehi Bertero ex. Vieillard, Sci. Nat. Bot., Ann. IV, **16**: 45, 1862.

Musa Seemanni F. von Mueller, Fragmenta **9**: 190, 1875.

Musa Sapientum Linnaeus subspecies *M. Troglodytarum* (Linnaeus) Baker, though he attributes it incorrectly to Linnaeus, Ann. Bot. **7**: 214, 1893.

Musa paradisiaca Linnaeus subspecies *troglodytarum* (Linnaeus) K. Schumann, though he incorrectly attributes it to Baker, in Engler, Pflanzenreich 1(IV.45): 21, 1900.

Musa sapientum Linnaeus variety *M. troglodytarum* (Linnaeus), anonymous though incorrectly attributed to Linnaeus, Kew Bull., 250, 1894; also reprinted as Add. Ser. **6**: 22, 1906.

variety **typica,** new variety.

Musa Troglodytarum Linnaeus, Sp. Pl., ed. **2**: 1478, 1763.

Inflorescentiae erectae, bracteis viridibus glabris obtusis numerosis (30 +).

Inflorescence erect, bracts green, glabrous, obtuse or rounded at the tips, regularly imbricated in large bud, bracts numerous (30+), sap exuding from cut surfaces violet in color.

Type: *M. Troglodytarum* Linnaeus, established by him based on Rumphius' plate and description (under the name of *Musa Uranoscopos*). Rumphius'

plate is interpreted to represent the type of the species. This typical element is represented by the two clones *tati'a* and *'afara*. From the evidence in hand, it appears that the clone known as *tati'a* more closely approaches that illustrated by Rumphius and reproduced in figure 14. The plants of *tati'a* found growing in the gardens of Tahiti (pl. 8, *A, D*) had the extended rachis and numerous bracts characteristic of Rumphius' figure. The bracts of the bud in his figure are not rounded at the tip. This, however, should not be given much weight, as the nature of the tip of the bracts is not given in Rumphius' description and as the original figure drawn from the plant was lost and was later redrawn by others under Rumphius' direction after he had become blind. The photograph furnished by J. C. Hamel (pl. 10, *A*) of a plant growing in a garden in Amboina closely resembles Rumphius' plate in having an extended rachis. Unfortunately, the bracts are not shown in this photograph.

variety **acutaebracteata,** new variety.

Differt in bracteis acutis paucis 6-12 evidentis, eis floribus masculis 25 vel minoribus, flora ultima abortiva saepe globosa. Nomen indiginarum tahitensarum 'aiuri.

Variety differs from type in having bracts of bud acute at tip and visible bracts few in number, 6-12, staminate flowers 25 or less, terminal flower often with globose, abortive ovary.

Type: Society Islands, Tahiti, District of Pueu, May 1927, *L. H. MacDaniels 30-27-9* (Bishop Museum).

The following technical description of *Musa Troglodytarum* Linnaeus variety *acutaebracteata* is based on variety *'aiuri.*

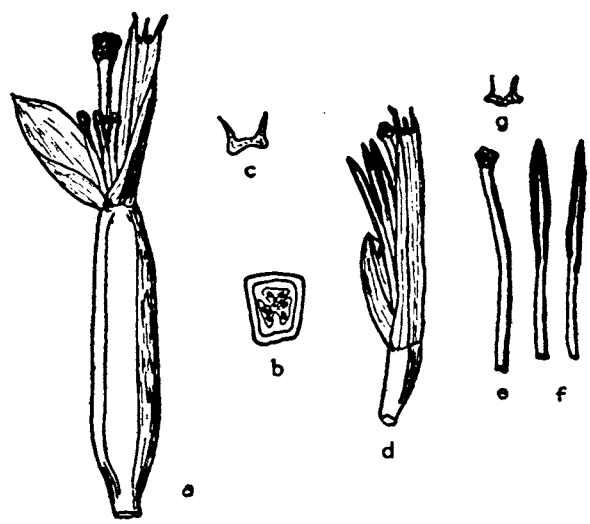

FIGURE 1.—Variety *'aiuri:* **a,** pistillate flower with functional ovary and rudimentary stamens; **b,** cross section of 3-celled ovary; **c,** cross section of fused perianth parts showing fleshy angles; **d,** staminate flowers with functional stamens and rudimentary ovary; **e,** pistil; **f,** stamens; **g,** cross section of fused perianth parts.

Plant stoloniferous forming large clumps. Trunk 5 to 7 m. high, black or dark purple below, green above, smooth below, frequently weathering to gray-brown at maturity. Sap exuding copiously from cut trunk, violet purple.

Leaves 3 to 4 m. long, by 0.5 to 0.6 m. broad, slightly tapering toward upper end, base variable, cuneate to cordate, unequal, green and glabrous throughout, somewhat lighter underneath, strongly veined, and longitudinally ridged due to tight rolling of developing leaves, entire in protected locations but split into segments when whipped by the wind. Midrib sunken below upper surface of leaf. Petiole 20 to 30 cm., usually with somewhat crinkly membranaceous edges.

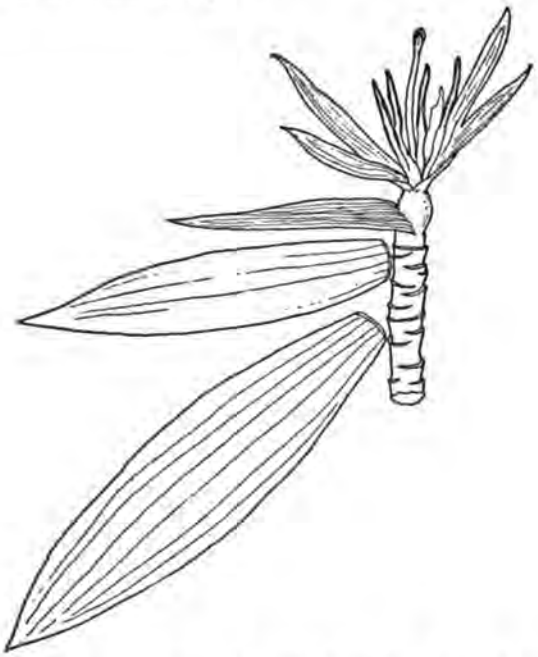

FIGURE 2.—Variety *rureva:* extended rachis showing pointed bracts and abnormal flower at tip; the bulbous base of this flower persists as a knob (1/3 natural size).

Inflorescence erect, enclosed by large green glabrous spathaceous bracts pointed at tip, not much imbricated (pl. 4, *C*). Pistillate flowers (fig. 1, *a*) 2 to 12 in each hand, subsessile in axils of lower bracts. Ovary 2 by 8 cm., straight, angled due to pressure, obscurely 3-celled (fig. 1, *b*). Perianth yellowish white or streaked with pink veins, basically, of six parts in two whorls, one member of inner whorl, the so-called petal, nearly free (fig. 1, *a*), 3 by 4 cm. long, elliptical or obovate, concave pointed at tip, the other five perianth parts fused to form an angular tube 5 to 6 cm. long, split on one side to base; thickened on dorsal angles (fig. 1, *c*); five prominent teeth at tip, the three larger representing the outer whorl of perianth parts. Pistil about 5 cm. long, fleshy style 6 mm. thick, stigma irregular or obscurely six-lobed, capitate, mucilaginous. Stamens 5 to 6 variable, shorter than style, flattened, sometimes with marginal anther sacs bearing white pollen, often without sporogenous tissue.

Staminate flowers (fig. 1, *d*) 2 to 4 in axils of each of upper bracts, 7 to 10 cm. long. Ovary rudimentary 1.5 to 2.5 cm., green. Perianth creamy white with pinkish cast due to colored sap in veins. Single petal obovate-concave, as in pistillate flowers; fused

perianth tube curved with fleshy angles and 5 terminal teeth (fig. 1, *g*), the three larger representing the outer whorl of perianth parts. Stamen 6 to 7 cm. long (fig. 1, *f*), anther sacs marginal, gray, reddish along edges, extending from tip over about half the length of stamen, dehiscing along margins to liberate abundant white pollen. Pistil equalling perianth tube in length, more slender than in pistillate flower, stigma flattened.

In the inflorescence there is a decrease in the size of the bracts from base to apex, also a tendency for the pistillate flowers at base to have less well-developed stamens than those toward tip. The transition from persistent pistillate flowers to deciduous staminate flowers is sharp, there being few intermediate forms observed except in varieties *'afara* and *tati'a*. In variety *'aiuri*, which is taken as the type, the extended rachis above the fruit is short, with 9 to 12 bracts, the upper ones without staminate flowers. The erect rachis of this and allied varieties usually terminates in an abnormal flower, which develops into a bulbous knob (fig. 2). (The small number of scars on the extended rachis and the bulbous tip were used by the Tahitian guides in variety identification.)

Fruit variable in size and shape depending upon position in bunch, basal fruits larger, 6 by 16 cm., angular, tapering from base to apex, not conspicuously beaked (fig. 3), extending at right angles from rachis or inclined downward. Upper fruits 4.5 by 14 cm., more rounded in cross section and at tip, inclined upward. Color clear, coppery orange when grown in the shade, darker in exposed situations with brownish streaks due in part to cracking of outer skin. Skin thick, separating readily from pulp of ripe fruit; pulp firm, yellow or with slight yellow-green cast, sweetish and astringent when raw but palatable when cooked. Fruits seedless most of the year. (See discussion of seed habit, pp. 13-15.)

Size of the plants and bunches variable according to the nature of the habitat. In general, medium-sized plants and fruit. Average-sized bunches with about 40 fruits, the lower hands with 7 to 9 and the upper with 1 or 2 fruits. (Under favorable conditions, bunches were observed with 60 to 75 fruits.)

The most significant characters that serve to differentiate this species from other species of *Musa* are as follows: black trunk at least at base, violet sap, erect inflorescence, green glabrous bracts, coppery orange fruit, which is unpalatable and astringent when raw but palatable when cooked, and the fact that eating the fruit discolors the urine.

Variants of Variety 'Aiuri

'Aiuri shows more variation than the others observed, and some of these variations are given local names. In Oroe Valley in the district of Teahupoo, one form is called *arutu*. The fruits are similar to those of *'aiuri* but somewhat larger, the basal fruits measuring 18 by 5.5 cm. The upper fruits are more rounded with a blunter apex than typical *'aiuri*. According to the Tahitian guide, whose statement was later confirmed by T. Nadeaud and Pau, the character that differentiates *'aiuri* from *arutu* is the presence of a small leaf close to the bunch (pl. 4, *B*) which was attached about an inch below the basal bract of the inflorescence. The name *'a'ai'a* is also applied to large fruited *'aiuri* types which have a small leaf just below the bunch (pl. 4, *B*). One guide stated that *'a'ai'a* has two such small leaves, whereas *arutu* has only one. There was, however, difference of opinion as to this point. From observation, I believe that the two names are used more or less interchangeably for large-fruited *'aiuri* types with a small leaf subtending the bunch. The name *teravero* was

also given for this variety but it apparently has little standing as compared with the other two, which Henry (14) places on a par with the other distinct varieties.

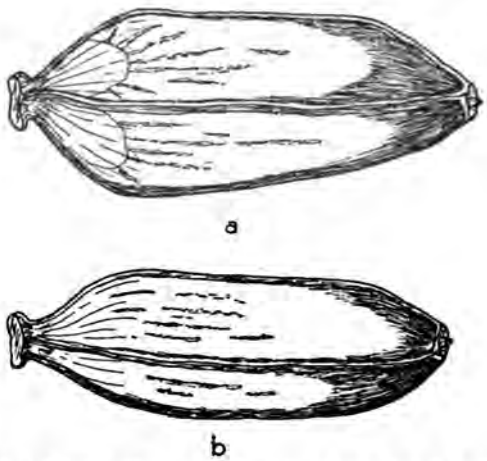

FIGURE 3.—Variety *'aiuri;* diagrams of mature fruit showing shape: a, basal fruit; b, apical fruit.

DESCRIPTIONS OF CLONES

The following descriptions of varieties are written to differentiate them from the type and from each other, rather than to give complete descriptions. Native names of varieties may not be established beyond question, but the names of the varieties described have been corroborated by many Tahitians and very little uncertainty as to names was encountered, except in the variants of *'aiuri* and *rureva.* The term variety is used here in the horticultural sense as referring to a clone.

RUREVA

Closely resembling *'aiuri* and its other variants is the variety known as *rureva.* Next to *'aiuri* it is the most frequently found variety in valleys wherever fe'i grows. This description is made from plants growing on the slopes back of Lake Vaihiria, on the ridge separating the valley of Vaihiria from that of Papenoo. Conditions are apparently ideal for fe'i and the plants grow with a luxuriance not observed elsewhere. The characters of the plant, buds, and fruits are essentially the same as those designated as *rureva* elsewhere, except for their larger size.

These large plants back of Lake Vaihiria are considered by some to be a distinct variety. But Pau Tane and T. Nadeaud, who considered the matter carefully, believed that they were *rureva.* I could find little to differentiate

them from *rureva* in other valleys, except size, luxuriance of growth and possibly less angular fruits.

Plants forming close clumps containing old dead trunks to young suckers. Young trunks purplish black at base, green above. Old trunks 6 to 8 m. high, 0.5 m. thick at base, with upper part weathering to grayish tan. Leaves 8 to 10 on mature plants, very large, blade 0.8 by 4 m., rounded or cordate at base, tapering toward tip, petiole relatively short (15 to 25 cm.), thick, flattened with crinkled winged margins.

Bud very large, 0.9 m. long from basal bract, sharply pointed (pl. 5, *A*) with 6 to 8 sharply pointed bracts showing. Bracts deep green, glabrous on outside, lighter green to straw-yellow inside. Pistillate flowers in hands in axils of bracts, the number in the axil of each bract beginning with the basal hand in one bunch counted as follows: 10, 12, 12, 8, 6, 2, 2, 3, 2, 2, 2, 2, 1, 1, 1. Floral parts essentially as in type. Well-developed staminate flowers wanting on bunches examined. Twelve to 20 sterile bracts on rachis above fruit, the upper sometimes colored purple. Extended rachis about 12 cm. ending in a bulbous tip bearing irregular floral parts as in *'aiuri*.

Bunch large, about 65 fruits in forms found on ridge back of Lake Vaihiria (pl. 1, *A*). Smaller, 35 to 40 fruits as observed elsewhere, roughly triangular or conic, crowded below,

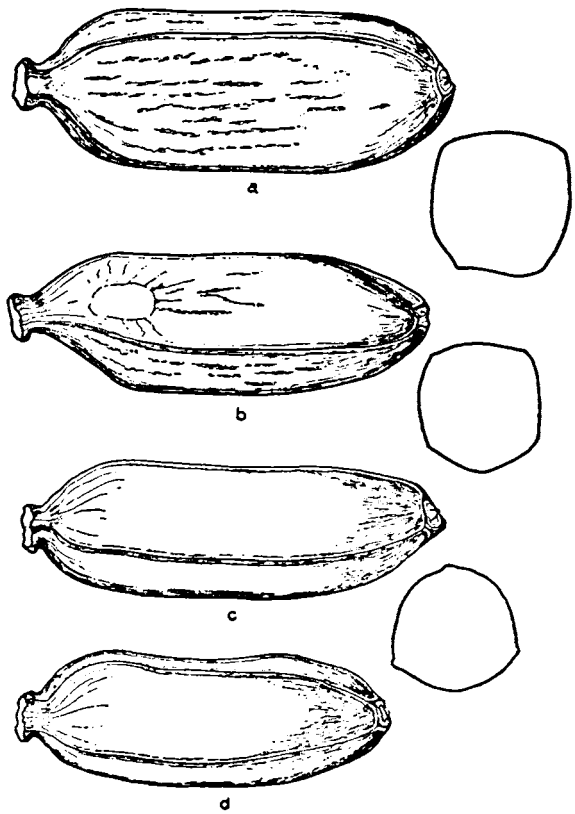

FIGURE 4.—Fruits of variety *rureva*. **a, b,** from Vaihiria Valley: *a*, basal fruit; *b*, fruit near apex. **c, d,** from Vairao district: *c*, fruit from base of cluster; *d*, fruit from near tip of cluster. The fruit from Vaihiria is larger, less angular and has a rougher skin.

loose above, the basal fruits extending downward. Rachis short and thick, 12 to 15 cm. Fruit (fig. 4), very large basal fruits 20 by 7.5 by 6 cm., nearly terete blunt at tip, upper fruits shorter, more rounded at base, on many bunches one of upper fruits double or much thicker than the others. Color usually coppery brown when growing in full sun or lighter when grown in shade. Skin rather thick, 3 to 5 mm., not separating as easily from pulp as in *'afara*, cracked giving a somewhat striped appearance or nearly smooth on fruit grown in shade. Pulp light yellow, astringent, core inconspicuous.

Although *rureva* is not clearly differentiated from *'aiuri* because of intergrading forms, the type differs in having larger fruits, which are not so angular, in the short, thick rachis below the bunch, in the looseness of the cluster above, and in the presence among the upper fruits of one that is either double or much thicker than the others. The fruits are darker in color than *'afara* but about the same as *'aiuri*. (See plate 5, *A*.)

'A'ata

'A'ata (pl. 5, *B*) is a distinct variety found growing wild in most of the fe'i valleys and is also cultivated. The variety, observed under cultivation in Vaihiria in two localities and wild in the Vavii Valley, Vairao district, was also seen on the Papeete market.

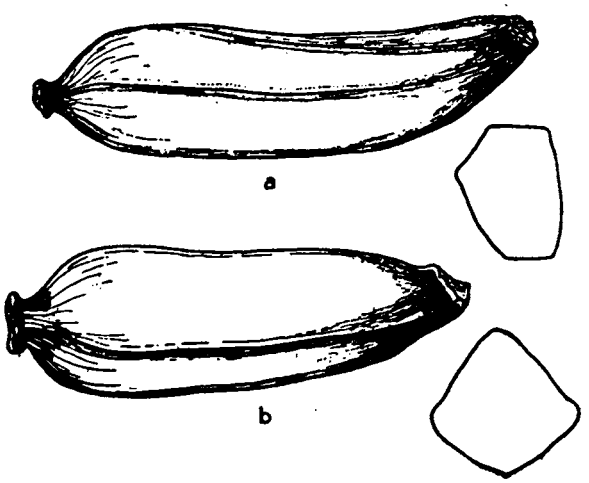

FIGURE 5.—Fruits of variety *'a'ata:* a, basal fruit; b, apical fruit. The tapering, angular, curved fruits are characteristic of the variety.

The wild plants form a close clump, the trunks about 6 m. high, black at base, weathering grayish tan above. Leaves closely crowded, petioles about 30 cm. on basal leaves, 20 cm. above, ruffled along edges. Blades broader below middle, tapering toward apex, rounded at base. Bud pointed at top with sharply pointed bracts. Flowers not seen. Extended rachis short with 10 to 15 bract scars. Apparently very few staminate flowers developed. Rachis terminating with bulbous tip, as in *'aiuri*. Bunch conical in shape, broad at base, with all but basal fruits pointing upward, crowded at base, loose above. Lower hands 10 to 13 fruits, upper 1 to 2 fruits. Fruits (fig. 5) large, 22 by 7 by 5.5 cm., strongly

angled at base and apex of bunch. Basal fruits with tips curving upward, tapering from a broad base to narrow apex, usually with a distinct beak. Skin not cracked or streaked in the four bunches examined. Color muddy brownish orange, not bright copper as in *'afara*.

Distinctive features of the variety are the large conical bunch and the large fruits, which are sharply angled and curved, tapering from base to apex usually with a distinct beak (fig. 5).

Ha'a

This variety was seen only once, in a plantation in the Vairao district. It is, however, quite distinct and is well known to the Tahitians.

Plants forming a close clump, mature trunks 4 m. high, stout, 40 to 45 cm. thick at the base, not tapering much, black at base, gray in middle and green above. Leaves very large, crowded at top of trunk, close to bunch. Petioles short, thick, ruffled, 20 to 25 cm. long on lower leaves, 12 to 15 cm. on upper, blade cordate at base, blunt at apex, 0.8 by 3.5 or 4 m. Rachis thick, about 13 cm., short, 15 cm. from upper leaf to first fruit. Bunch short, conical, 60 cm. wide at base and about same height (pl. 5, *C*), 50 to 60 fruits, crowded below, looser above but not so loose as *'a'ata*. Lower hands 8 to 10 fruits, upper 1 to 3.

Fruits at base large, 20 by 6.5 cm., angular, thick at base, tapering toward apex, somewhat curved upward, pointed (fig. 6, *a, c*). Apical fruits much shorter, 15 by 6 cm. thick, rounded with obscure angles (fig. 6, *b*). Skin somewhat checked and cracked and of a dull brownish-orange color resembling that of the variety *'aiuri*. Bracts sharply pointed, as in *'aiuri*, extended rachis short with 6 to 9 bract scars, ending in bulbous tip 2 to 4 cm. in diameter. Staminate flowers apparently few.

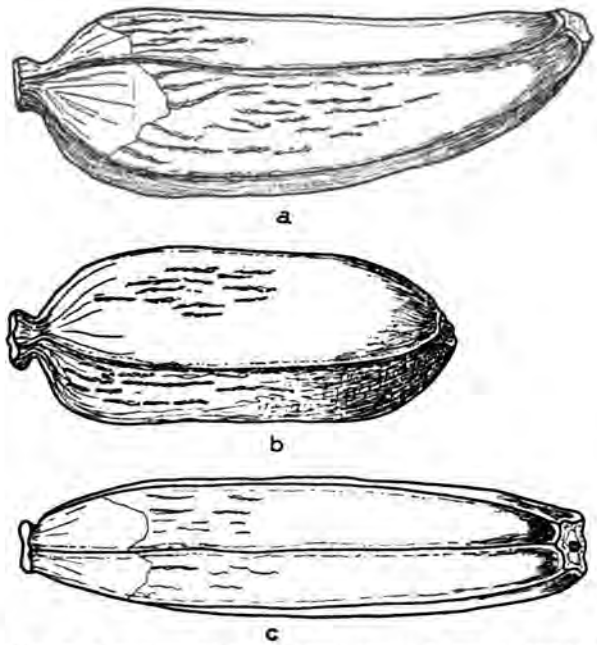

Figure 6.—Fruits of variety *ha'a:* a, basal fruit; b, apical fruit; c, top view of basal fruit.

The distinguishing characters of the variety are the short, thick trunk, large, broad, conical bunch with fruits large, angular, and tapering at base but much shorter and rounded at tip of bunch. The only other variety resembling it closely is *'a'ata,* which has a taller more slender trunk and looser bunch without rounded fruits at apex of bunch.

Paru

Paru is a well-known but relatively rare variety, observed wild in Pueu (pl. 5, *D*) and cultivated in Vairao district. Plants in Pueu formed a somewhat scattered clump by underground stolons; cultivated plants formed a closer association.

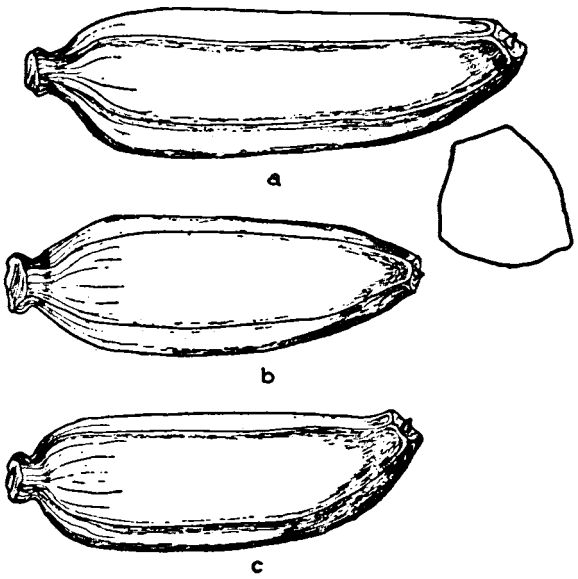

Figure 7.—Fruits of variety *paru:* **a**, basal fruit; **b**, apical fruit viewed from above; **c**, apical fruit viewed from side.

Trunk tall, 6 to 7 m., medium slender; younger ones dark maroon below shading to dark green above; older ones weathering grayish tan below, green above. Leaves large, lanceolate oval, about 3 by 0.7 m., lower leaves cordate at base, upper rounded. Petioles medium short with crinkled edges. Rachis stout, about 30 cm. between upper leaf and lower fruits. Bunch large, 65 to 80 fruits, compact, tapering very slightly, or sides nearly parallel. Fruits nearly alike on base and apex of bunch, somewhat smaller, less angular above than below (pl. 5, *D*). Basal fruits (fig. 7, *a*) angular, 15 by 5.5 by 5 cm., not tapering from base to apex, with a rather prominent beak. Apical fruits (fig. 7, *b, c*) 14 by 5 by 4.5 cm. Fruits larger under cultivation. Color dark coppery orange, sometimes with cracks in skin as in variety *'aiuri.* Extended rachis longer than in *'aiuri* with 25 to 30 scars indicating staminate bracts, staminate flowers about 10, judging from scars. Bud large (pl. 5, *D*), sharply pointed, with about 8 bracts with pointed tips showing.

This variety resembles *tati'a* in the shape of bunch and fruit. The chief difference is that the bracts on the bud of *paru* are sharply pointed, whereas those of *tati'a* are rounded. The staminate flowers also are more numerous and better developed in *tati'a*. *Paru* differs from *'aiuri* and *rureva* in having a less tapering bunch and a longer extended rachis.

MAHANI

Mahani is a relatively rare variety observed growing wild in the valleys of Vairaharaha, in the Mataiea district and in Vaihiria Valley. The best plants were in Vairaharaha, where there were many plants intermingled with those of *'aiuri*. Several bunches were examined.

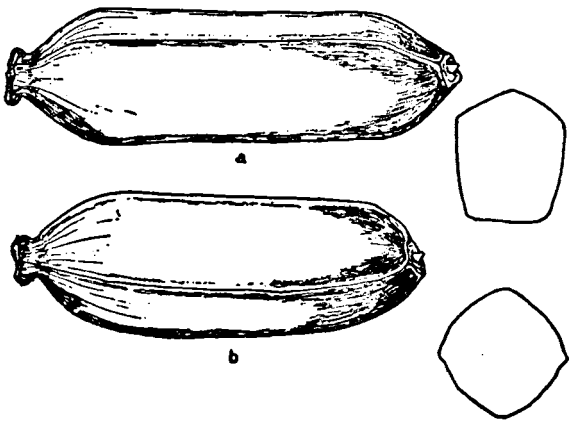

FIGURE 8.—Fruits of variety *mahani*: **a**, basal fruit; **b**, apical fruit.

Plants forming rather loose cluster. Trunks very large, 6 to 7 m. tall, 38 to 45 cm. at base, tapering only slightly. Young plants black at basal 4 feet, older trunks lighter, giving spotted appearance. Leaves very large, crowded at apex of trunks, petioles broad and thick with dark spot on back, edges widely ruffled, short, 25 cm. on basal leaves, 12 to 15 cm. above. Leaf blades broad, 0.7 by 3 m., cordate at base, even in upper leaves, tapering gradually toward apex from broadest point below center. Bunch large, about 45 fruits, broadly ovoid crowded, flaring below, loose above (pl. 6, *A*). Rachis short, thick, about 15 cm. from basal fruit to first leaf which is usually much smaller than other leaves.

Basal fruits very large, 22 by 6.5 by 5.5 cm., angled but with bulging sides, not tapered toward apex, with distinct short beak (fig. 8, *a*). Apical fruits more rounded, hardly angled at all, without beak (fig. 8, *b*). In each bunch there is usually one fruit larger, thicker, and rounder than the others at the same level that stands nearly vertical (pl. 6, *A*), the extended rachis being inclined to one side. Skin thick, rather tough, adherent to pulp which is bright yellow, soft, tender, with no core and very little astringency. One of best varieties for eating. Color bright coppery orange, smooth, without conspicuous checking or striping. Extended rachis with 20 to 25 bract scars terminating in small bulbous tip as in variety *'aiuri*. Bracts sharply pointed.

Mahani is a distinct variety distinguished by the very large plants with spotted trunks; short, broad petioles; cordate leaf bases; and very large fruits, not conspicuously tapering to apex, of clear coppery orange color; and particularly by the presence of large vertical fruit at the apex of the bunch which forces the extended rachis to one side. According to the Tahitian guide, Pau, the variety called *turua no ti ohoro* is much like *mahani* but with less pointed fruits. This variety was not seen for certain, although Pau identified from a photograph one bunch found back of Lake Vaihiria as this variety.

Toro Aiai

According to T. Nadeaud and Pau, *toro aiai* is the same as *arapoi*, the two being distinct names for the same variety. The former name refers to the large size of plant and fruit. The variety was seen only once in Vaihiria Valley.

Plants very large, forming a close clump, 50 cm. at base tapering to about 30 cm. at apex, green nearly to base even when in fruit. Leaves about 10 in number on mature plant, crowded at apex of trunk, petioles thicker than broad, stout, medium length, about 30 cm. on basal leaves. Upper leaves nearly sessile. On the bunch examined the lower spathaceous bract had a leaflike tip. Leaf blade very large, about 0.8 by 4 m., ovate-cordate at base, tapering toward tip (pl. 6, *D*).

Bunch very large, 65 fruits, elongate, conical, less crowded at base than *mahani*, above very loose. Basal fruits angular, pointed, somewhat tapering toward apex, 22.5 by 7 by 6 cm. Skin fairly smooth, clear, coppery orange but with more cracks than in *mahani*. Extended rachis short, about 7 cm. with 12 bract scars. Bud not seen but, judging from nature of rachis and the statement of the guide, the bracts are pointed as in variety *'aiuri*. (Others consulted concurred in this.)

This variety is rare but is distinct and well known. It is distinguished from *mahani*, which it resembles, by the more tapering trunk that is green nearly to the base instead of black and by the absence of large fruit at the tip of the bunch. Also, the fruits tend to be more angular and tapering than those of *mahani*. The tip of the rachis on specimens observed lacked the terminal bulb in *toro aiai*.

Oeoe

This variety was not seen growing. The only bunch I observed was being carried out of Vaihiria Valley by a Tahitian fe'i hunter (pl. 6, *C*). Although the variety was not well known in some valleys because of its scarcity, it is distinct and not easily confused with any other.

Plants not seen. Bunch with about 40 fruits, roughly ovate, sprawling, the fruits not crowded and somewhat floppy. Fruits very long and narrow, 25 by 4.7 cm., angular, giving four-sided outline in cross section. It was stated by T. Nadeaud and Pau that in some bunches the fruit was even longer, up to 30 cm. The tip of the fruit is prolonged into a prominent beak 3 cm. long by 2 cm. wide in some specimens (fig. 9). This beak is called *utu* by Tahitians.

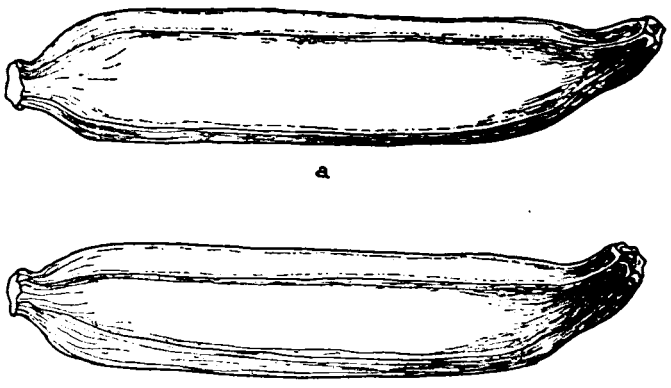

FIGURE 9.—Variety *oeoe:* diagrams showing character of fruit; the prolonged beak is characteristic.

Extended rachis short. (Bracts not seen but from statement of Nadeaud and appearance of rachis they are pointed as in *'aiuri.*) Skin rather rough, dark in color, resembling *'aiuri.*

Oeoe is readily distinguished by the long slender fruits not tapering toward the apex, which terminates in a pronounced beak. The variety represents the extreme variation in length and slender shape. It is not considered to be of good edible quality.

'U'URURU

'U'ururu is a distinct and well-known variety occurring rather frequently in most of the fe'i valleys. Plants were observed in Vaihiria Valley and in Faaroa Valley of the Vairao district.

Plants medium sized, 5 to 6 m. tall, forming loose clumps from rather wide offsets. Trunks relatively slender, black at base, weathering grayish tan above. Leaves 6 to 8 on mature plant, broad, elliptical or tapering toward apex, 0.7 by 2.6 m., wider in proportion to length than leaves of *'aiuri,* rounded at base. Petioles medium stout, sharply ascending 30 cm. on basal leaves, 15 cm. on upper, margins slightly ruffled with dark edge. Apparently characteristic of variety to have one small leaf, 0.6 m. long, just below bunch. Rachis about 30 cm. between bunch and first normal leaf.

Bunch medium sized or small—40 fruits, narrowly triangular, compact below, very loose above (pl. 6, *B*). Basal fruits somewhat angular, short, 12 by 5.5 cm., medium fruits more nearly rounded, 11 by 6.5 cm. Fruits toward tip 7.5 by 6 cm. Apical fruits spaced some distance (5 cm.) apart, often deformed at tip with prolonged fleshy beak evidently derived from the persistent pistil and other floral parts. (See figure 10, *a-c.*) Color bright coppery orange, like *'afara.* Skin usually without cracks or brown stains. Extended rachis above bunch short, without bulbous tip on specimens seen, usually with 3 to 9 bract scars. Bracts with pointed tips as in *'aiuri.*

'U'ururu is easily distinguished from other fe'i varieties by the small round fruits in a small triangular bunch, loose at the top with short rachis lacking a terminal knob. This variety is not considered to be of good eating quality.

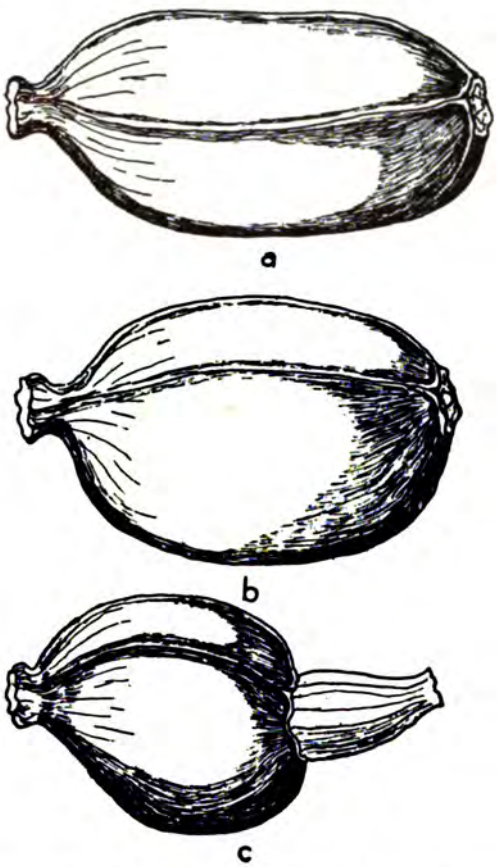

FIGURE 10.—Fruits of variety *'u'ururu:* a, basal; b, median; c, apical. The persistent beak formed from fused flower parts of the apical fruits is characteristic.

POTI'A

This is a rare variety found only after prolonged search in the Vairao district, in the valley of Naunau, the left hand branch of the valley of Vaipoi. Known to occur sparingly in some other valleys, it has been reported from Vaihiria. Plants growing on steep talus slopes differ in appearance from other varieties.

Trunks 6 to 7 m. tall forming a close clump, slender, not tapering, not black at base as in most varieties. Young plants with tinge of red on trunk. Old trunks weathering gray-tan below, remaining green above. Leaves, 8 to 10 in mature plants, rather crowded. Petioles long, about 30 cm., slender, sharply ascending with dark blotch at base, ruffled along membranous edges. Leaf blades long, narrow, 0.5 by 3 m. tapering toward tip. Leaf bases mostly broadly cuneate, not rounded or cordate (pl. 9, *A*).

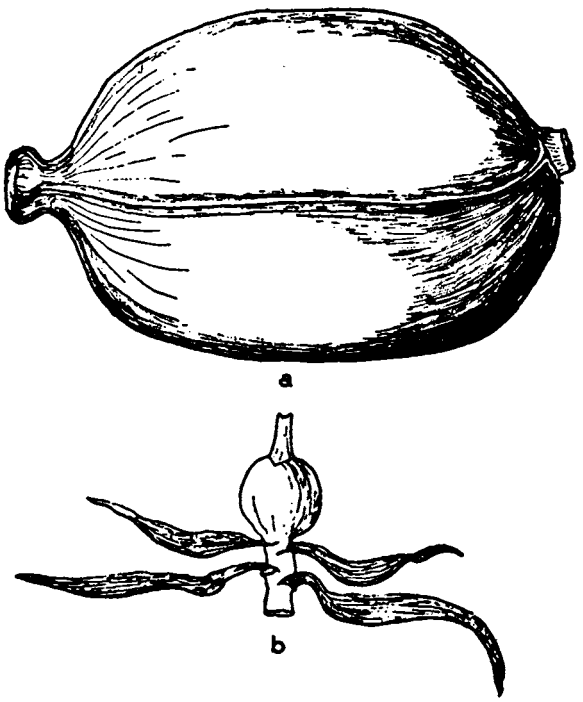

FIGURE 11.—Variety *potĭa:* a, diagram of fruit; b, tip of rachis above bunch showing terminal fruit and bracts.

Bunch with few fruits, the one under observation with 14 arranged in axils of bracts as follows, beginning at the base: 3, 3, 3, 2, 1, 1, 1. (T. Nadeaud and others believed that the bunch was not typical of the variety *potĭa* as there were too many fruits and these too small. Other bunches referred to by them had only 3 to 5 larger fruits. The fruits in the bunch under observation were obviously immature and their mature size is only estimated.) The extended rachis terminated in a globular fruit 7 cm. in diameter (pl. 9, *B;* fig. 11, *b*). Between this and the first fruit below were only 4 bracts apparently without staminate flowers. Rachis below the bunch long, about 45 cm. to first leaf with three sterile bracts, these large and sharply pointed (pl. 9, *A, B*). Fruit ellipsoid, mostly rounded at base and apex except a few basal fruits on bunch, 16 by 9 cm. size of immature fruit (fig. 11, *a*). Normal size of mature fruit reported as 22 by 14 cm. Pistil large and persistent.

Potĭa is easily distinguished from the other fe'i varieties by its large, breadfruit-shaped individual fruits, green trunks instead of black, and narrow leaves with cuneate base. It is doubtful whether the plants observed were *potĭa* because of the large number of fruits. However, if this is not true, it is another distinct variety for which there is no recognized name. I am of the opinion that the variety is the true *potĭa,* that the small size is due to immaturity, and that the large number of fruits is merely a variation. The fruit is not considered good eating, as compared with *'afara* or *'aiuri.*

'Afara

Trunk 5 to 7 m., rather slender, black at base, otherwise green, weathering gray-brown, usually not so gray as *'aiuri.* Leaves not crowded at top of trunk, petioles with crinkly edges, 30 cm. in length on basal leaves, 20 cm. on upper. Leaf bases next to bunch cordate, often unequal. Bud very large, pointed with many (40 to 50) regularly imbricated sheathing bracts with rounded tips (pl. 7, *A*). Basal staminate bracts enclosing 3 to 4 staminate flowers, apical with 1 to 2 staminate flowers all well developed. Extended rachis without bulbous tip. Staminate flowers in axils of some of basal bracts with persistent, rudimentary ovaries (pl. 7, *B*).

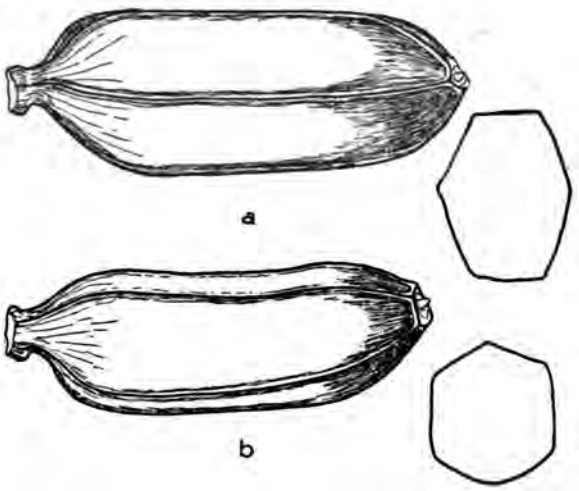

Figure 12.—Fruits of variety *'afara:* **a,** basal; **b,** apical.

Bunch variable, often large with 75 to 100 fruits, very compact throughout, cylindrical (pl. 7, *B, C*). Fruit small, as compared with other varieties, 8 to 10 in axils of bracts. Basal fruits 15 by 5.3 by 4 cm., angled, somewhat flattened, not conspicuously tapering to apex. Apical fruits 14 by 5 by 4.5 cm., less angular than basal fruits (fig. 12). Color bright coppery orange, without skin cracks.

'Afara, next to *'aiuri* and *rureva,* occurs with greatest frequency in all the valleys, making up about 4 to 5 percent of all fe'i gathered. It is highly prized for its eating quality and attractive appearance. It is easily identified by the cylindrical bunch of small, tightly packed fruit of clear orange color and especially by the length of the extended rachis and number of bract scars on it. The bracts of the unopened bud are rounded at the tip and regularly imbricated, a character found only in *tati'a* among the other varieties.

Tati'a

A well-known variety observed in Vaihiria Valley and in the valleys of the Taiarapu Peninsula, *tati'a* is one of the most frequently cultivated varieties. On the lowlands, it produces large bunches of large fruits. The following description is taken from wild plants in Aravaro Valley, Teahupoo district.

Plants forming rather close clumps. Trunks 5 to 6 m. tall, 0.5 to 0.6 m. diameter at base, green above, weathering gray-tan, black below. Leaves 6 to 8 on mature plants, rather crowded on short petioles 15 cm. long on upper leaves, 25 cm. on lower. Base rounded or cordate, blade narrowly oval, tapering both ways from near middle, 0.7 by 3 m. (pl. 8, *C*).

Bud very large with many round-tipped, imbricated bracts (pl. 8, *A*), as in *'afara*. Staminate flowers well developed, 4 to 6 within each of basal bracts, 1 to 3 within terminal. Bunch very large (pl. 8, *B*), 126 fruits on bunch counted with hands of following numbers, beginning with basal bracts: 11, 14, 14, 13, 12, 12, 11, 10, 8, 9, 7, 4, 1, cylindrical or only slightly tapering. Fruits crowded, basal, angular, 18 by 6 by 6 cm., not tapering toward apex. Apical fruits less angular, shorter, 16 by 6 by 5 cm. (fig. 13, *a, b*). Color, coppery orange, usually not so bright as *'afara* but brighter than *'aiuri*. Skin usually not cracked, but sometimes showing checks, rather thick, 3 to 5 mm., separating readily from flesh. Flesh of ripe fruit clear yellow, astringent with biting after effect (seemingly more astringent than *'afara*).

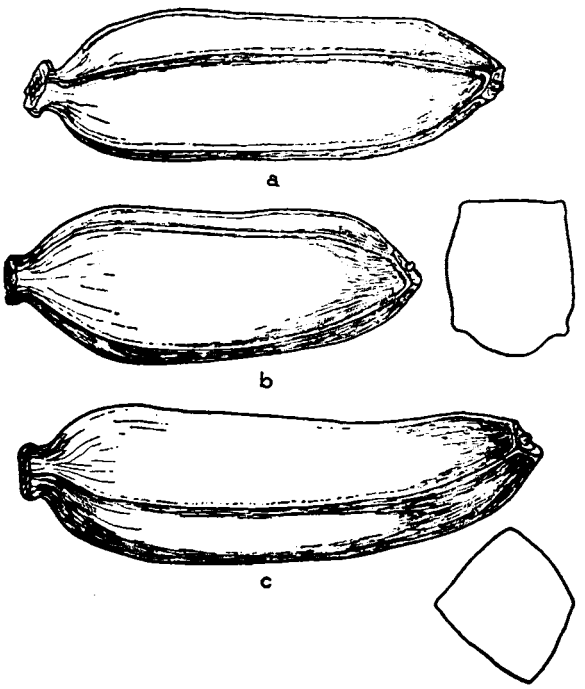

FIGURE 13.—Fruits of variety *tati'a:* a, basal; b, apical; c, basal fruit from cultivated plant.

Like *'afara,* this variety is regarded as of good quality. Although resembling *'afara* closely, it is distinguished from it by the larger size of fruits and bunch and somewhat darker color. The two varieties, *'afara* and *tati'a,* are apparently closely related phylogenetically and are placed together as belonging to the type species in variety *typica.*

The variety *tatiʻa* under cultivation on the lowlands shows rather striking differences from the wild upland forms. Not only are the cultivated plants larger, as would be expected, with heavier bunches of larger, more angular fruits (fig. 13, *c*), but the extended rachis is much prolonged on cultivated plants. In the lowlands at the foot of Vaihiria Valley a plant was observed with the extended rachis nearly 2 meters long and the unopened bud still made up of many unexpanded bracts with well-developed staminate flowers in their axils. Although the bunch was nearly erect, the rachis was bent over rather sharply at the top of the bunch and hung down at an angle of about 60 degrees with the bunch. On the base of the rachis immediately above the bunch were many rudimentary ovaries from hermaphrodite flowers. The old bracts on the extended rachis had not been shed cleanly but had weathered off along the basal part of the rachis. Near the tip around the bud the bracts were still persistent.

In the Vairao district on the windward side of the Taiarapu Peninsula, a plant of *tatiʻa* was found on the flatland at the base of the valley. The long extended rachis was entirely covered with persistent bracts, a condition which might be explained by the greater humidity in this protected situation which prevented abscission. On the other hand, the persistent bracts may indicate another clonal variant which should be distinguished from the usual form of *tatiʻa*. The bunch on this plant was somewhat inclined from the vertical, probably bent over by the weight, which when wet must have been considerable, of the persistent bracts and rachis.

The behavior of plants of *tatiʻa* in producing a prolonged rachis when grown on the rich alluvial lowlands, as against the short bracts of the upland forms, was considered by Tahitians characteristic of this variety. It is of botanical interest certainly, in that it might be interpreted as an intermediate form or phylogenetic transition between the mountain feʻi and the lowland *Musa sapientum*. As indicated, however, the origin of both species is obscure and the above is only speculation. Obviously the transition from an upright or inclined bunch with a pendent extended rachis to a bunch that is pendent due to a crook in the rachis below the bunch is not great. Also, the presence of hermaphrodite flowers with persistent rudimentary ovaries on an extended rachis in the cultivated forms of *tatiʻa* is almost identical with the condition found in many of the forms of *M. sapientum*. A closer study of the forms described by Wilder (46, p. 34) from Rarotonga and of those found in the Solomon Islands would be of interest. One form designated as *uatu pi vai* is described by Wilder as having the fruit cluster erect but the extended rachis drooping, a condition identical with the cultivated forms of *tatiʻa* here described from Tahiti. The other form described by Wilder, under the native name *pou tu*, holds the bunch erect until it begins to ripen, when the whole bunch hangs down as in *M. sapientum*. This seems to be an even closer approach to *M. sapientum*.

The 13 varieties and forms of the fe'i banana observed fall into two natural groups, based upon the nature of the bud and the extended rachis. In one group, here designated as botanical variety *typica,* including the varieties *'afara* and *tati'a,* the green bracts covering the unopened flowers are many and regularly imbricate with rounded tips (pl. 7, *A*).

The extended rachis beyond the pistillate flowers is relatively long with many scars of bracts and clusters of staminate flowers. As found on bunches of fruit of these varieties in the mountains, scars numbered about 50 and the upper end of the rachis gradually tapered toward the tip. The Tahitians recognized the importance of this character in identifying varieties and, asked to identify any bunch, examined the top to note the nature of the tip and the number of scars. Variety *tati'a,* as cultivated in the gardens along the coast, had a very long, extended rachis which bent over the bunch. This is essentially the same as shown by Rumphius (32, p. 139) in his original figure of *M. Uranoscopos.* Rumphius' statement that the species described was confined to gardens on Amboina would add further weight to the opinion that the two were the same. The accuracy of Rumphius' figures is doubtful, because the originals were destroyed by fire and the plates redrawn by artists under his direction. Rumphius, who was blind at the time of redrawing, did not see the plates himself (22, p. 16). However, the photograph furnished by Hamel

FIGURE 14.—Rumphius' figure of type in Herbarium Amboinense (5: 139, pl. 61, fig. 2, Amsterdam, 1750).

from Amboina (pl. 10, *A*) shows a form with an extended rachis bending over like that in Rumphius' figure and like the plants of *tatiʻa* growing under cultivation in Tahiti. (See figure 14.)

This form with the extended rachis is of interest taxonomically, because of its apparent relationship to the form described by Rumphius and because it might be considered an intermediate form more closely allied phylogenetically to the species of *Musa* with the inflorescence nodding. Possible hybridity is also suggested.

In the other group of varieties designated as botanical variety *acutaebracteata* MacDaniels, including all those except *ʻafara* and *tatiʻa*, the tips of the bracts are pointed instead of rounded, and instead of being regularly imbricate, most of them extend to the tip of the unopened bud or nearly so (pls. 4, *A;* 5, *A*). The bracts are relatively few in number showing only 5 to 10 on the unopened bud, in contrast with 30 to 40, or more, on varieties of the other group. The extended rachis in this group is relatively short with few scars and, in some varieties, often terminates in an abnormal flower, which may develop into a bulbous swelling (fig. 2). This fruit is usually round, always smaller than the fruit in the basal positions, and usually not edible.

KEY TO VARIETIES AND CLONES OF FEʻI

The following key to the botanical varieties and clones of the feʻi banana observed in Tahiti has been prepared to aid in variety identification. A key of this sort has many limitations, first, because of the relatively small amount of material upon which it is based, and second, because of the variation within the clones due to environmental conditions. The key, however, represents the results of nine weeks' study in the field and the best opinions available from feʻi hunters and others familiar with the species in the wild. Thus, it should be of value in emphasizing the differences between the various forms. That these forms do differ markedly and consistently, has been shown by the preceding descriptions and figures and by the plates. Plate 10, *C, D* shows a comparison of fruits of a number of different clones.

Key to varieties and clones of Musa Troglodytarum Linnaeus observed in Tahiti

A. Bracts enclosing inflorescence blunt or rounded at tip, many (30 or more) evenly imbricated on bud. Extended rachis long with 30 or more bract scars. Fruit compactly arranged on bunch. Botanical variety *obtusaebracteata.*

B. Fruit small averaging about 15 cm. in length. Skin bright coppery orange without cracks ..... **ʻafara.**

BB. Fruit larger, averaging about 18 cm. Skin usually duller than *ʻafara* with obscure checking and cracking..... **tatiʻa.**

AA. Bracts on inflorescence sharply pointed at tip, few, 6 to 12, showing in unopened bud, not evenly imbricated. Extended rachis short with less than 25 scars, usually with bulbous tip. Botanical variety *acutæbracteata.*
  B. Fruit broadly oval or nearly round, averaging less than twice as long as broad.
    C. Fruit small, less than 12 cm. in length. Many fruits on bunch (30 or more) ..... **'u'ururu.**
    CC. Fruits large, 15 cm. or more long at maturity. Few fruits on bunch (3 to 15, usually 4 to 5) ..... **poti'a.**
  BB. Fruit elongate, more than twice as long as broad.
    C. Basal fruits on bunch conspicuously tapered from base to apex, somewhat curved upward.
      D. Fruits angular throughout bunch. Trunk tall, 5 to 6 m., not more than average thickness ..... **'a'ata.**
      DD. Basal fruits angular, upper rounded. Trunk short, 4 m., thick, not tapering ..... **ha'a.**
    CC. Basal fruits not conspicuously tapered from base to apex.
      D. Fruits long, slender, 25 by 4.7 cm., with conspicuous upturned beak 2 to 3 cm. long. Bunch loose ..... **oeoe.**
      DD. Fruits without conspicuous beak relatively shorter and thicker than in D.
        E. Bunch large, closely packed, cylindrical, resembling variety *tati'a* ..... **paru.**
        EE. Bunch broadly triangular or ovoid, loose at least above.
          F. Fruits of clear coppery orange color, like *'afara* even when exposed to sun. Plants and fruits very large. Cracks in skin few or wanting.
            G. Bunch with single fruit near apex, much larger than others extending nearly vertical. Trunks dark at base, mottled above ..... **mahani.**
            GG. Bunch without large vertical fruit at apex, trunk not mottled, green nearly to base ..... **toro aiai** (syn. **arapoi**).
          FF. Fruits coppery brown in color, at least when exposed to sun. Cracking of skin often conspicuous.
            G. Bunch large, triangular, loose above with one or two fruits near apex double or larger and more rounded than the others ..... **rureva.**[1]
            GG. Bunch usually medium in size, not loose above, without large, or double fruit near apex.
              H. Bunch with small leaf about 0.3 m. long subtending bunch ..... **arutu** (minor variant of *'aiuri;* syn. **'a'ai'a**).
            HH. Bunch without small subtending leaf ..... **'aiuri.**

ORIGIN AND DISTRIBUTION OF THE FE'I IN PACIFIC ISLANDS

Before the distribution of a plant can be used as significant evidence as to the direction of migration of the people who used the plant, it is necessary to determine where it is indigenous. This presents a problem difficult of certain solution now, when old legends and customs have been lost and the native floras are becoming more and more confused with foreign introductions.

[1] Because of intergrading forms it is impossible on the basis of information on hand to make a good technical separation of the varieties *rureva, 'aiuri, 'a'ai'a,* and *arutu.* The differences brought out in the key are those usually recognized.

The plant geographer, A. De Candolle (6, pp. 9-28) gives the following lines of evidence as important in determining the origin of a species:

1. Botany: particularly the present distribution of the plant as it grows wild. The greatest geographical concentration of species of the same genus and allied genera also has a bearing on the problem.
2. Archaeology and palaeontology.
3. History: particularly journals of explorers and native legends.
4. Philology: a study of native names and their origins.

To these might be added the study of the relation of the native flora and fauna, particularly endemic insects, to the species. The application of these points to the fe'i banana will be considered briefly.

Considering all species of *Musa*, it is generally agreed by botanists that the center of distribution of the edible forms is in the Malay Peninsula and the East Indies (6, 17, 30). Granting that the *M. Uranoscopos* of Rumphius is the same species as that of Seemann, which is certainly the *M. Fehi* of Bertero, the western limit of distribution is in the Moluccas. It is significant to note that Rumphius records the plant as present only in gardens and as rare on Amboina and more common on the coast of Ceram. It may be that the cultivated forms were brought from the islands farther east. There appears to be no authentic record of the species farther west, either on the mainland of Asia or the neighboring islands. Botanists refer repeatedly to the occurrence of *M. Troglodytarum* on Ceylon, as catalogued by Moon (25), but this quite certainly does not refer to Rumphius' species with upright inflorescence. Merrill and others state that the fe'i banana does not occur in the Philippines. It is obvious, therefore, that the center of distribution does not coincide with that of most of the closely related forms of the genus as a whole, but rather to the east of it.

The distribution of the fe'i banana, insofar as it has been observed or recorded, is indicated by crosses on the accompanying map (fig. 15). A consideration of the source and authenticity of the various reports of its occurrence is pertinent. These have been assembled by correspondence and conference over a period of more than 10 years. Many attempts to gain information about the plant have been in vain, as the region between Fiji and the Moluccas is little known botanically.

Except for the records from the Moluccas, the most western station from which bananas with upright inflorescence resembling the fe'i are reported is Boana, at 3,100 feet altitude, near Morobe in northeast New Guinea. M. S. Clemens has furnished a photograph of the plant, about 30 feet high (pl. 10, *B*), which closely resembles the fe'i banana in its upright bunch and extended rachis. The plant is common in the bush near Boana but is not found at the lower altitudes. It is highly probable that this is the same species as the fe'i banana, particularly in the light of the evidence furnished by Frank Kajewski,

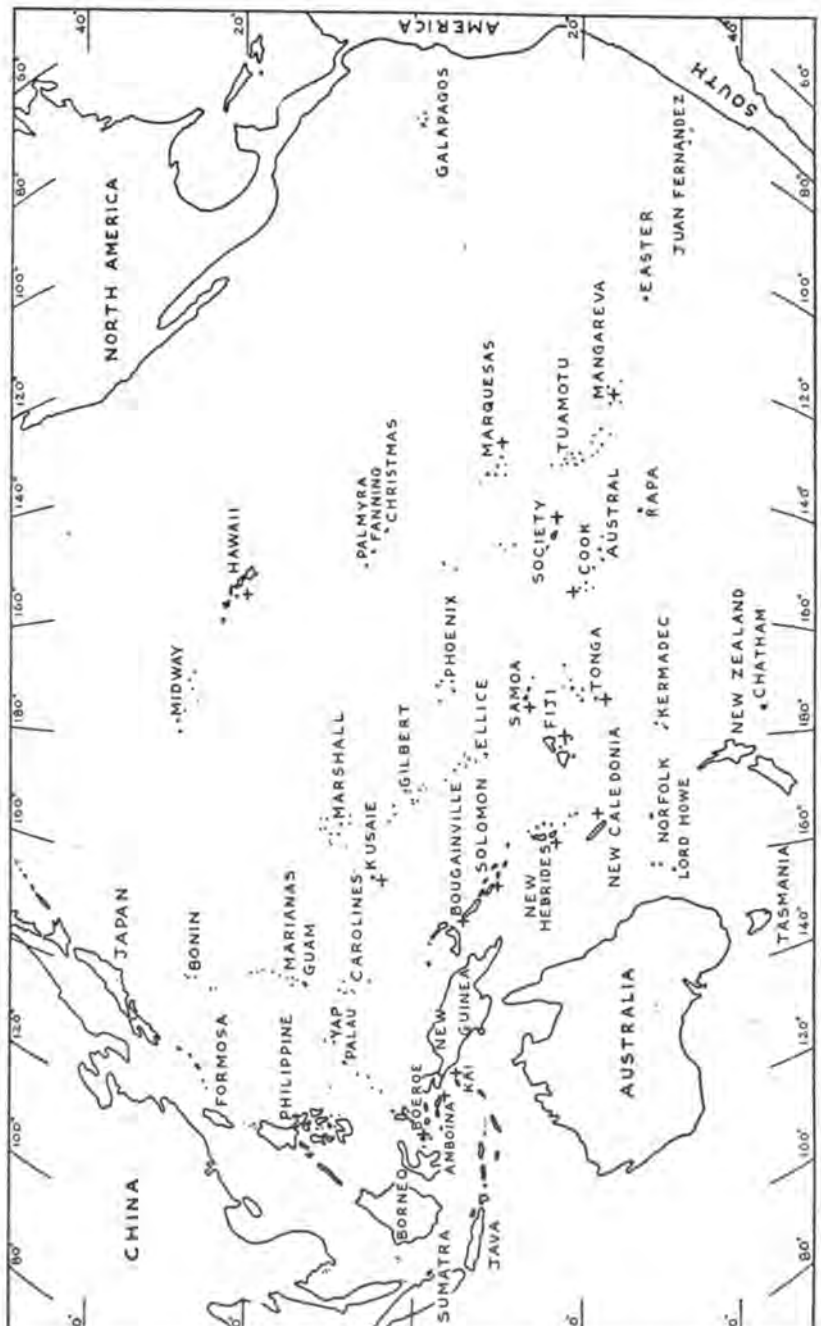

FIGURE 15.—Map showing the distribution of the fe'i banana; crosses mark observations or collections of species.

a plant collector in Bougainville in the Solomons. Kajewski, who had at his disposal pictures and descriptions of the fe'i banana as it grows in Tahiti, writes as follows:

> In answer to your queries I am certain one form is found on the Island of Bougainville of the Musa you require information about.
>
> The stem is one of the largest I have seen in Bananas, growing up to forty feet high, with a diameter of almost two feet. The fruit is an orange colour, full of hard black seeds. The bunch is erect. The sap is of a violet colour and has been used by prospectors as a substitute for ink. The outer skin of the stem is very dark.
>
> There are large areas of it on Bougainville and the rain forests are full of it. The fruit is of course useless, there being no pulp to speak of and having an astringent taste. This is a mountain species growing above two thousand feet altitude and is indigenous.
>
> Another form full of seeds grows near the coast. This is not quite as large as the bush form and its fruit is a bit smaller. The fruit is full of black seeds and useless.

The plant has also been reported from the Solomon Islands by Captain E. A. Salisbury, who visited there to make a motion picture. He was sure that the fe'i banana occurred there and in the New Hebrides, but he did not see it in New Guinea. Apparently the plant is not present in all parts of New Guinea, for F. J. Brass, on returning from the American Museum of Natural History Expedition to Netherlands New Guinea (probably the southwest part), writes as follows:

> Again, I am sorry to say, I have not been able to find anything that looked like your plant. As probably you are aware, our operations were centered in the mountains of the far interior. Two sections of mountains were worked. The lower section, in which our operations extended from altitudes of 50 to 2150 m., was uninhabited, except for a wandering tribe of sago-eating people on the lowlands. In five months we saw not a single cultivated banana, and only three wild species. None of these wild species resembled *M. Fehi.*
>
> Once a few hands of a fat, angular coppery-colored fruit with orange-yellow flesh of somewhat "native" flavor, were brought to our camp from a distance, but I did not see this apparently rare kind of growth.

The fat, copper-colored fruit with orange-colored flesh might very well have been the fe'i banana, but there is no certainty of it. Obviously the species is not well known in that part of New Guinea.

An authentic account of the plant in the New Hebrides, where the native name is *chongk,* comes from F. J. Paton, a life-long resident there, who states that the plant occurs everywhere on the islands, wild and in cultivation. There are a number of different forms or varieties some of which may contain seeds. Seeds, however, are not used in propagation. The plant gives every evidence of being indigenous, being well adapted to competition with native vegetation and thriving rather better at higher altitudes than near the shore. There are no legends as to the importation of the plant, and the natives believe it to be indigenous. The fruit is used for food. Paton also had photographs and descriptions of the Tahitian fe'i for reference.

The record from Kusaie, Caroline Islands, was given by George C. Lockwood (conversation), who has spent much time there as a missionary. He recognized photographs of the plant as identical to those growing on Kusaie. Whether or not the plant is indigenous there is uncertain. This is probably the banana described by Higgins (16, p. 46) and named for the island from which it was introduced about 1890. He considers it different from *M. Fehi* Bertero, probably belonging to *M. sapientum* var. *Troglodytarum,* which is the *M. Troglodytarum* of Linnaeus. As shown elsewhere in this paper, these names refer to the same plant. The description falls well within the limits of the variation of the fe'i banana of Tahiti.

The type description of *M. Fehi* Bertero was made from plants in New Caledonia where it is apparently abundant in the mountains. Confirmation that the plants in New Caledonia are the same as those growing in Tahiti comes from Raiarii, chief of the district of Tautira, on the Taiarapu Peninsula on Tahiti (1927). He had been stationed in New Caledonia for a considerable length of time and had observed the plants growing there. According to him, the most common form resembled the variety *'afara.*

According to Seemann (36), about 18 forms occur in the mountains of Fiji. I observed one clump of the fe'i banana along the Waidina River about 40 miles from Suva. Although lacking ripe fruit, it was without doubt the same species as those in Tahiti. The natives of Viti Levu knew of a number of forms of the plant which they called *soaqua.* It was not regarded as an important food plant there.

I did not see the fe'i banana growing in Tonga, but the native guides said it was there and called it *soa'a*[3] the name used in Samoa. Apparently the plant was not highly regarded as a source of food, for other forms of native bananas were abundant and the fe'i was not among them. Many varieties of *M. sapientum* were observed on Tongatabu and Vavau.

In the short time spent in Upolu, Samoa, I did not observe the fe'i banana. It was well known to the natives under the name of *soa'a,* however, and at the Government Experiment Station there were young plants which had been procured locally. This name is evidently a modification of the Fijian *soaqua.* In Upolu, where there is more bush than in Tongatabu, a seeded form of *M. sapientum* is common as a wild plant. No fe'i are among the other bananas although the habitat seems suitable.

From the Cook Islands, Wilder (46) reports the fe'i banana in several forms known as *'uatu.*[4] Of special interest is the variety known locally as *'uatu pi vai* with the extended rachis that becomes pendent as it elongates. Whether or not this is the same as the variety *tati'a* in Tahiti is uncertain.

[3] In Samoa, the dropped *k* is represented by the hamza in *soa'a,* and it is questionable whether this is an old form in Tonga, where the *k* is not dropped.

[4] The glottal in the Cook Islands represents *k* and the name *huatu* means standing fruit.

The varieties and distribution of fe'i on Tahiti have already been discussed in detail. Without much doubt the species reaches its greatest diversification and use in the Society Islands. It is reported by J. W. Moore as growing in abundance on Raiatea and is known to occur on Moorea, Huahine, and other islands of the group.

In the Marquesas, the diversification and use of this species must be much the same as it is in the Society Islands. Brown (5) reports its occurrence in abundance and names three varieties known to the natives of Nukuhiva. A seed-bearing form was collected at high altitude on Fatuhiva by W. B. Jones, to whom the plants appeared to be indigenous to the island. Brown (5) also reports that seeds occur in one form in the Marquesas but that they are rare.

During the months spent in the Hawaiian Islands, I found several clumps of fe'i on Oahu, the best known along the Tantalus Trail, in Nuuanu Valley, and in Manoa Valley (pl. 9, *C*). They were unquestionably the variety *'aiuri*. Plants growing in the Federal Experiment Station were of this variety. A clump of fe'i bananas is reported from Kahana Valley by Olaf Oswald. The plants are growing among mountain apple trees (*Eugenia malaccensis*) with a large breadfruit tree nearby, indicating that it was the site of a native garden. On Kauai are several stands of the plant, the most luxuriant in Wainiha Valley. There fe'i grows in two places, one large luxuriant clump and another smaller one downstream from it. The variety is either *'afara* or *tati'a*, as the buds are typical of these varieties (pl. 7, *A*). Mature fruit was not seen. In another valley, along the Wailua River, plants of *tati'a* were found growing along the stream (pl. 9, *D*). On Hawaii, the species was not seen except in the garden of Puo Pahinui on the Kona side of the island and at Hilo in the garden of T. A. Dranga. The plants grew luxuriantly, producing bunches, and in both gardens were evidently the variety *'afara*. There are well authenticated records of the plant being on Maui also.

In the Hawaiian Islands, the fe'i banana gives little indication of being indigenous, although it grows well and more than holds its own with the native vegetation in some situations. The absence of seeded forms also indicates that it is not indigenous. According to Pope (29), it is of comparatively recent introduction and was probably not among the plants brought by the natives before the discovery of the islands by Captain Cook. Certainly the plants are not distributed in any way comparable to other native bananas. The name *borabora*, by which the plant is commonly known, indicates recent introduction. On the other hand, Mr. Rice of Lihue, Kauai, knew it by the name of *hai'i* which might have been derived from the Tahitian fe'i. *Hai'i*, however, is also applied to a variety of *M. sapientum* in the *maoli* group. MacCaughey (21, p. 2) states that the Hawaiians also call the plant *he'e*, probably derived from fe'i. Higgins (16, p. 45) states that it is not spoken of as a "native banana." The size of

the group of plants in Wainiha Valley on Kauai suggests that they have been there longer than the supposed date of importation would permit. The fe'i might have been brought in by natives in early times, as well as after the discovery of the islands by Cook; but all the evidence considered, the fe'i was apparently introduced into Hawaii by the white man in recent times.

In considering the present distribution of the plant, we find gaps in the record. If we consider Rumphius' species on Amboina in the Moluccas to be the same as the fe'i banana with which we are dealing in Tahiti, New Caledonia, Bougainville and northeastern New Guinea, as seems logical, there is a gap of about 2,000 miles from which there is no authentic record. A search through accounts of German exploration in Papua and New Guinea has failed to reveal records of the plant there and Salisbury states that although it was common in the Solomon Islands, he did not see it in New Guinea. Brass also failed to find it in New Guinea. If the plant is indigenous in Bougainville and is found also in Amboina, it is highly probable that it occurs somewhere in between, either in the islands or possibly on the continent of Australia. It remains for further exploration to complete the record of fe'i distribution.

The distribution of the seeded forms is important in determining the center of distribution of an asexually propagated plant, and has been helpful in the study of the distribution of the breadfruit in which seeded forms are concentrated in the Malay Peninsula and the Philippines. Many of the other species of *Artocarpus* are in the same region. According to Kajewski, the forms of the fe'i banana which grow in abundance on Bougainville are so full of seeds as to be inedible. Rumphius' species also had many seeds though the forms found there now are mostly seedless. In the New Hebrides, however, or the east, Paton reports that although seeded forms were known to the natives, the seedless forms are more common and are propagated by suckers. In Fiji, most of the varieties are seedless. In Tahiti, seeded forms are relatively rare, and this is apparently true of the Marquesas. In the Hawaiian Islands, seeded forms are rare, though they have been reported (16, p. 46). Thus the concentration of seeded forms of the fe'i banana is in the region of Bougainville, probably including the other Solomon Islands and the lands somewhat farther west to northeastern New Guinea.

There are no archaeological relics or fossils, any more than there are old historical accounts, to shed light on the origin and distribution of the fe'i banana in the Pacific. The account of the voyages of discovery, and the later works of Henry (14), Ellis (12), and others, describe the fe'i banana much as it is today except for its gradual disappearance from some valleys. One Samoan legend recounted by Seemann (35) states that the mountain and the lowland plantains had a fight, in which the *soaqua* (*M. uranoscopus*), that is the mountain plantains, or fe'i, won. Flushed with victory, they raised their heads, where-

as the vanquished were so humiliated they never raised their heads again. The same story is told by Henry (14, p. 35). Such legends are at least an indication of antiquity.

Native names give little indication of the origin of the fe'i banana, as far as I have been able to determine. The name found at the western limit of distribution, namely *pisang tonghat langit,* is a modification of the term *pisang* which applies to all bananas in that region. Paton reports the name *chongk* for the New Hebrides and Vieillard gives *daak* for New Caledonia. In Fiji, *soaqua* is the name used, and this is carried over into western Polynesia in the *soa'a* of Samoa. On Vavau in the Tongan Islands, the term fe'i was in use, though according to K. P. Emory the older usage would be *soanga.* In eastern Polynesia, the name *huetu* is reported by Brown (5, p. 161) for the Marquesas and *uatu* [*'uatu*] for Rarotonga by Wilder (46, p. 33). The name fe'i is found in the Society Islands, its variant (*ve'i*) in Aitutaki, according to Peter H. Buck. The Hawaiian name *borabora* (16, p. 45) is obviously a recent designation, indicating the island group from which the plant was brought. MacCaughey (21, p. 2) states that the Hawaiians also call it *he'e* which, like *hai'i,* is probably derived from fe'i.

The lack of similarity of names of the fe'i banana might well indicate that this plant was not widely known or used by Polynesians at an early date and that the plant was either picked up during the migrations and distributed, or found in the islands where the migrants became established. In such a situation new and unrelated names would be applied.

Considering all the evidence, I believe that the fe'i banana is indigenous to the region of the Solomon Islands, including the territory somewhat farther west. This original center may have included the New Hebrides, New Caledonia, New Britain, and parts of New Guinea. From this region, it probably spread very early into the other island groups of the Pacific to the east and was carried back, westward, to the Moluccas. The predominance of the seedless forms in the regions farthest from this center, both east and west, is logical, as the most useful types would be carried by migrants. A similar situation obtains with the breadfruit, seeded forms of which rarely occur in Polynesia but are common farther west where the plant is recognized as indigenous. There is, unfortunately, an important gap in our knowledge of the plant between the Solomons and the Moluccas, although this is probably partly bridged by the record given by Clemens for northeastern New Guinea. It is entirely probable that Rumphius' species, which he describes as occurring only in gardens, was brought from the east. A better knowledge of the flora of this great region will aid in a more reliable interpretation of the origin and distribution of this plant.

Antiquity of the Fe'i Banana in Tahiti

If the fe'i banana did originate in the region west of Fiji and was carried eastward with the Polynesian migrations, the length of time that the plant has been on any island group is of importance in indicating the antiquity of those migrations. In the Hawaiian Islands, the introduction of the plant was recent. In the Society Islands, however, horticultural and botanical evidence indicates that the plant has been present for many centuries. On Tahiti, which I explored thoroughly, the fe'i banana gives every indication of being indigenous. It is apparently perfectly adjusted ecologically, particularly at altitudes of 500 to 800 meters. It shows neither the exuberance of the introduced plant growing in a favorable environment without natural checks nor the losing struggle of an introduced plant not adapted to its environment and unable to compete with native vegetation. However, fe'i bananas are now suffering from inroads of introduced species which overrun all the native vegetation. The plant is so obviously a part of the native flora that it has been considered indigenous in Tahiti (28), and it may prove to be so with more accurate knowledge of the Pacific island flora. At present, the main reason for considering it an introduced plant is the occurrence of so many seedless forms and the relative scarcity of seeded ones in Tahiti, as compared with New Caledonia, the New Hebrides, the Solomon Islands, and islands to the west where seeded forms are reported to predominate. The fact that the center of distribution of the other allied species of banana lies to the west also points to its origin west of Tahiti. If more critical study should prove these reported forms to be another species, it would change the whole interpretation. But evidence indicates that this is unlikely.

It is difficult to determine the length of time necessary for an introduced plant to become as well adjusted to a new environment as the fe'i banana appears to be in Tahiti. The plant is not one that would spread rapidly by natural means, as practically all forms found at present are seedless. There was little indication of seedling plants, the clumps in any location giving the impression that they had been growing for many years. No critical study was made, however, to determine the age of the clumps of plants encountered or to search for young ones. The most probable interpretation of the wide distribution of seedless forms is that they were carried from place to place on Tahiti by the Polynesians who lived there.

The Society Islands at one time supported a much larger population than they do now, and more attention must have been given to the production of food. At the time of the discovery of the islands, as reported by Wallis (45), houses and gardens were seen far up in the valleys, giving the impression that there were many thousands of people. As fe'i were adapted to growth in the uplands where breadfruit and taro did not thrive, it is likely that they were

planted on mountain slopes and in the heads of valleys. This may account for the occurrence of a distinctive clone, like *'u'ururu* or *poti'a,* in isolated spots in widely separated valleys. Such artificial distribution could take place only if all these forms were already there and available. It should be recognized that distribution and adaptation to environment are two quite different problems.

The length of time necessary to differentiate the varieties found on Tahiti from the original type also has important bearing on the length of time the Polynesians have been there. If the many varieties of fe'i now found in Tahiti were introduced in their present form, the time necessary for their distribution and adjustment on the island is relatively short compared with that required for the differentiation of these varieties from a common stock by any known method. Any interpretation of the antiquity of fe'i on Tahiti hinges on these two possibilities. If these clones were brought there in their present form, the present distribution and adaptation on the island could have taken place within the Christian Era; if, on the other hand, they have arisen from a common introduced parent stock, the time probably required for such differentiation is much longer.

Although available evidence indicates that the Society Islands have more varieties of fe'i than are found elsewhere, a thorough survey in Fiji and island groups farther west is necessary to prove this point. I did not find evidence of a wide diversity of forms of the fe'i banana in Fiji in 1927, although several were known to the native guides, nor is there evidence of such diversity anywhere outside of the Society Islands.

The many forms of fe'i in Tahiti may have arisen in a number of different ways, among them (a) variation or mutation of seeded forms, (b) hybridization of two closely allied species or seeded variants of one species, (c) by vegetative mutation either with or without artificial selection, or (d) by a combination of these methods.

The first possibility seems unlikely in Tahiti because of the relative absence of seeded forms. It is unlikely, though possible, that seeded forms were much more plentiful but have been destroyed by the Tahitians because of their inedibility.

This same reasoning would also apply to the hybrid origin of seeded forms or species. Hybrid origin seems quite probable with the cultivated forms of the common banana (*Musa sapientum*), as several similar species are known (18) which may have contributed to the genetic constitution of these edible forms. Further, the pollen of the cultivated bananas, particularly the *Gros Michel,* behaved like hybrid pollen in germination tests conducted in 1926, the samples used showing a lack of uniformity of shape and size of grains and of germination. The pollen of the fe'i banana, variety *'aiuri,* did not show evi-

dence of hybrid origin. This work is suggestive only, as it requires many more trials of pollen samples of different origin to give any sound basis for judgment. Further cytological study of chromosome numbers and pollen behavior would be of value.

If the fe'i banana is a hybrid between two similar species, the second species is unknown at present. It may be discovered in the region between Amboina and Bougainville, or possibly the form on Bougainville and on northeast New Guinea is sufficiently different from the type to be given specific rank. That the seedless fe'i are hybrids between the seeded type of fe'i and some form of *M. sapientum* or allied species is not probable, because of the distinctive characters of the fe'i. On the other hand, the glaucous form reported from Rarotonga by Wilder (46, p. 34) in which the bunch becomes pendulous as it ripens, though it is erect when it flowers, suggests hybridity. The drooping of the extended rachis in variety *tati'a* and the bent over rachis of forms on Amboina also suggest hybridity. Germinating seeds of different types and growing the plants to fruiting would shed light on the problem, for the degree of variation of the seedlings produced would indicate the genetic constitution of the species.

Origin of the diverse seedless forms by vegetative mutation is a real possibility. Such mutations do occur rather frequently in many horticultural plants. So far as I know, however, there are no records of mutation for the fe'i or other bananas. Either such mutations occur rarely, or they occurred in ancient times when climatic or other conditions not now apparent were particularly favorable to mutation. In either case, the fe'i banana must have been in Tahiti for an exceedingly long time for such a diversity of forms to originate in this way.

The origin of a new variety or clone by bud mutation and its dispersal might be effected by man. To what extent the Tahitians, or another ancient race, in various island groups practiced artificial selection is unknown. It seems that some selection must have taken place, at least to the extent of preserving new forms as they appeared; otherwise, it is difficult to account for the persistence of the variants now found.

The rapidity with which variants arise is increased, according to recognized principles of plant breeding, by vegetative mutation to form diverse types which are seed bearing and the subsequent hybridization of these forms. Under such circumstances, wider variation is likely to occur among these seedlings than among those from similar parents. The diverse forms of fe'i, however, may have arisen by a combination of all the methods suggested, and it is speculation to designate which one. The evidence indicates to me that the fe'i has been in the Society Islands and adjacent island groups from ancient times. The present trend in determining the origin of cultivated plants is to place the

origin far back in prehistoric times (43), and the fe'i banana seems to be no exception.

The postulation of some prehistoric land connections is very helpful in explaining the distribution of plants in the island groups of the Pacific. Natural means of plant dispersal over wide stretches of ocean seem to me inadequate to account for the similarities in the mountain floras of Tahiti and Hawaii and of other high islands. Many of the affinities of these floras point to an ancient common origin of genera, followed by species differentiation through long ages of segregation. One possibility of more recent land connections is indicated in the lowering of the ocean level during the glacial periods, due to the withdrawal of the water as ice. Such lowering has been variously given as 150 to 300 feet (10, p. 182). Improved methods of sounding of what appear to be submerged canyons and river systems (39) may disclose indications that the water level was lowered an even greater distance, a condition which, if it did not actually cause land connections, would have greatly increased the size of the land masses above the surface of the ocean and thus facilitated dispersal. If such land connections did exist in prehistoric times, the problem of the dispersal of the fe'i banana in eastern Polynesia is much simplified and its introduction in Tahiti before the arrival of the Polynesians much more likely. The diversity of forms on Tahiti raises doubts as to the introduction of the fe'i into the islands by the Tahitians, at least in the Christian Era. It is also at least plausible that fe'i was brought into the islands at an earlier date by people now unknown. It may even have been indigenous there.

SUMMARY

In this study a fairly thorough exploration of Tahiti and considerable collecting on Viti Levu in Fiji; Tongatabu and Vavau in Tonga; Upolu in Samoa; and Oahu, Hawaii, and Kauai in the Hawaiian Islands, resulted in the collection of 13 varieties and forms of the fe'i banana which are described and illustrated. These fall into two natural groups: one representing the type as described by Rumphius, with a long extended rachis above the bunch on which the bracts covering the bud are numerous, imbricate, and rounded at the tips; the other designated as *acutaebracteata* with the extended rachis short with relatively few sharply pointed bracts.

This field experience, together with extensive correspondence and study of literature, leads to the following conclusions:

1. That the fe'i banana of the Society Islands is the same species as that found in Fiji, New Caledonia, the New Hebrides, and the Solomons, and that these are identified with the *Musa Uranoscopos* of Rumphius described from Amboina in the Moluccas.

2. That the valid name of the fe'i banana thus becomes ***Musa Troglodytarum*** Linnaeus, as Linnaeus refers specifically to the *M. Uranoscopos* of Rumphius in naming this species.

3. That the probable origin of the fe'i banana is in the region centering about the Solomon Islands or possibly somewhat west of them and that the species, particularly the seedless edible forms, have been dispersed both east and west, probably with the Polynesian or other migrations and voyages.

4. The western limit of distribution of fe'i appears to be the Moluccas and to the east the Society, Marquesas, and Mangareva Islands.

5. Botanical and horticultural evidence indicates that the fe'i has been in the Society Islands for many centuries, possibly before the Christian Era. Introduction into the Hawaiian Islands is known to be recent.

6. The many clones showing great variation in size and shape of fruit and, to a lesser extent, variations in vegetative characters are thought to be variants of a single species. A study of the pollen does not indicate hybridity.

7. Further study of the occurrence of clones and similar species on the islands west of Fiji and east of the Moluccas is needed to determine whether the many forms of fe'i in Tahiti existed elsewhere and were brought into that island or were differentiated from a common stock in the Society Islands. The interpretation of the antiquity of fe'i there hinges on this point.

J. C. Hamel has brought to my attention a paper by Anton Rant (31) which confirms the findings of this study as to (1) the presence of the *Musa Uranoscopos* of Rumphius in Amboina and Ceram, (2) the identification of this species in Amboina with the *M. uranoscopus* of Seemann and the *M. Fehi* Bertero of Vieillard, (3) the probable introduction of the forms in Amboina from the islands to the east, (4) the fact that the present valid name for the species is *M. Troglodytarum* Linnaeus.

The plants reported in the Moluccas show three distinct varieties that appear to be the same as some of those found in Tahiti. Rant's plate 2, the "pissang toengkat langit" of Rumphius closely resembles the Tahitian variety *'afara*. His plate 3, with larger fruits, resembles the clone *tatī'a*. Both of these varieties belong to the botanical variety *typica*, with the extended rachis and many obtuse imbricate bracts. Rant's plate 4 shows a clone resembling the Tahitian *a'ata* very closely, a variety with short rachis and few pointed bracts. What probably was a fourth form was observed in Java at a country fair, where it had been brought in by Chinese gardeners. This is the farthest west at which the species had been observed.

Rant had no firsthand knowledge of the species outside the Moluccas and was not aware of the many diversified forms growing in Polynesia or in Melanesia to the east. The paper is of great value, because it approaches the prob-

lem of the distribution of the fe'i banana from west of the probable center of distribution, whereas my study was made from the east. Together they clarify many points which were previously obscure.

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INDEX

(Principal reference in boldface, scientific and native names in italic.)

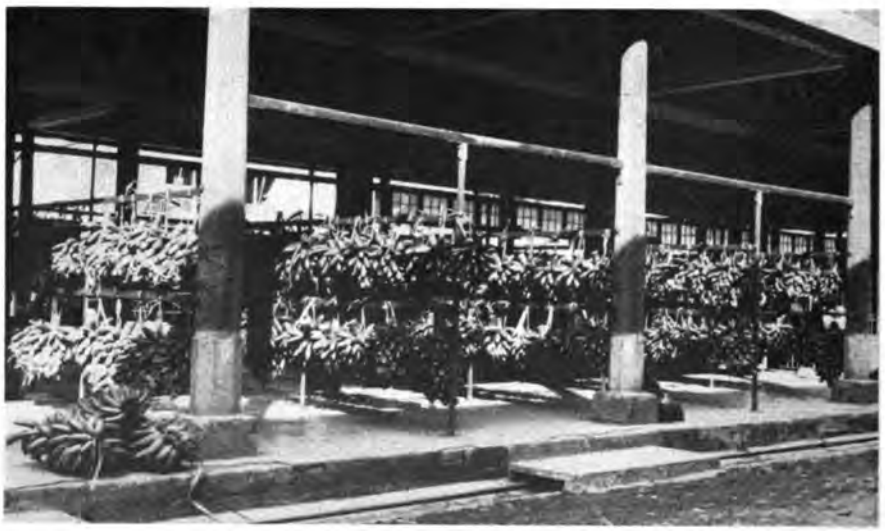
A

B

C

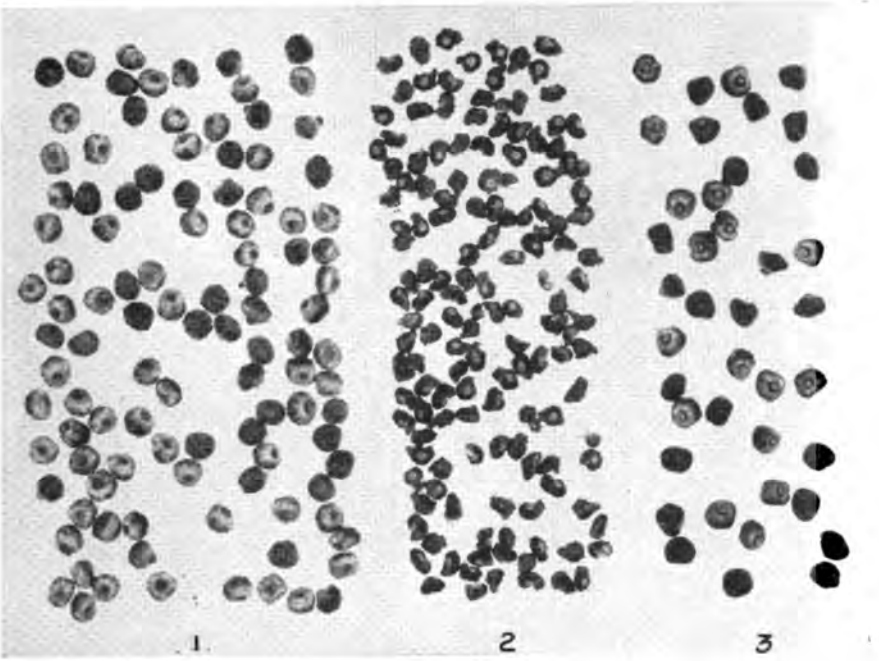
A, BUNCH OF VARIETY *RUREVA* FROM FAR SIDE OF LAKE VAIHIRIA. B, FE'I CARRIER WITH FLESHY PAD ON NECK AND SHOULDERS. C, TAHITIAN CARRYING LARGE BUNCHES OF FE'I, VARIETY *RUREVA* LASHED TO POLE OF *PURAU* WITH THONGS FROM SIDE OF MIDRIB OF FE'I LEAF.

A



B

A, TRANSPORTING FE'I TO MARKET FROM PUEU AND VAIRAO. B, MARKET PLACE IN PAPEETE, SHOWING QUANTITIES OF FE'I, ALMOST TO EXCLUSION OF OTHER TYPES.



A

B

A, BANANA SEEDS: 1, SEEDED TYPE OF *M. SAPIENTUM,* BOTANICAL GARDENS, CALCUTTA; 2, SEEDS OF FE'I BANANA, VARIETY *'AIURI,* TAHITI; 3, SEEDS FROM WILD BANANA, *M. SAPIENTUM* IN FOREST IN SAMOA. **B,** SEEDED TYPES IN TRANSVERSE SECTION: 1, TOP, SEEDED FORM FROM SAMOA, BOTTOM, SEEDED *M. SAPIENTUM* FROM CALCUTTA; 2, 3, FE'I BANANA, VARIETY *'AIURI,* TAHITI. NOTE THAT THE SEEDS OF THE FE'I BANANA ARE POORLY DEVELOPED AS COMPARED WITH THE OTHERS.

A

B

C

D

A, OPENING BUD OF FE'I BANANA, VARIETY *'AIURI*, SHOWING LARGE BRACTS, PISTILLATE FLOWERS, AND UNOPENED BUD ENCLOSING PISTILLATE AND STAMINATE FLOWERS. B, VARIETY *ARUTU*, OROE VALLEY, TEAHUPOO; THE SMALL LEAF SUBTENDING THE INFLORESCENCE IS THE CHARACTER DIFFERENTIATING THE VARIETY FROM *'AIURI*. C, FE'I BANANA, VARIETY *'AIURI*, TEAHUPOO: CENTER OF PLANT SHOWING ERECT HABIT OF INFLORESCENCE, BASAL BRACTS, PISTILLATE FLOWERS, AND POINTED TERMINAL BRACTS. D, VARIETY *'AIURI*, TEAHUPOO DISTRICT: MATURE FRUIT.

A

B

C

D

A, BUDS OF VARIETY *RUREI'A*, SHOWING THICK RACHIS AND POINTED BRACTS. B, BUNCH OF FRUIT OF VARIETY *'A'ATA* GROWN IN LOWER VAIHIRIA VALLEY; THE LARGE, ANGULAR, STRONGLY TAPERED FRUIT ARE CHARACTERISTIC. C, FRUIT OF VARIETY *HA'A;* THE SHORT, CONICAL BUNCH AND SHORT RACHIS ARE CHARACTERISTIC OF THE VARIETY. D, FRUIT AND BUD OF VARIETY *PARU;* NOTE IRREGULARLY ARRANGED POINTED BRACTS AND EXTENDED RACHIS ABOVE BUD NOT ENDING IN BULBOUS TIP.

A

B

C

D

A, VARIETY *MAHANI:* LARGE FRUIT STANDING NEARLY UPRIGHT IN CENTER IS CHARACTERISTIC OF THE VARIETY. B, VARIETY *'U'URURU:* SMALL FRUITS AT APEX OF BUNCH NEARLY GLOBOSE. C, VARIETY *OEOE:* LONG, SLENDER FRUITS WITH PRONOUNCED BEAK AND LOOSE BUNCH ARE CHARACTERISTIC. D, VARIETY *TORO AIAI:* VERY THICK LEAF PETIOLES AND CROWDED LEAVES; NO EXTRA LARGE UPRIGHT FRUIT AT APEX OF CLUSTER, AS IN *MAHANI.*

A

B

C

VARIETY *'AFARA:* **A,** OPENING BUD SHOWING PISTILLATE FLOWERS AND MANY ROUND TIPPED IMBRICATE BRACTS. **B,** BUNCH SHOWING SHAPE AND NATURE OF EXTENDED RACHIS. **C,** BUNCH (LEFT) IN MARKET WITH THREE BUNCHES OF *'AIURI* SHOWING DIFFERENCES IN SIZE OF FRUIT AND BUNCH CHARACTERS. THE FRUITS OF THE TWO BUNCHES AT THE RIGHT ARE PADDED WITH DRY FE'I LEAVES.

A

B

C

D

VARIETY *TATI'A:* **A**, LARGE OPENING BUD SHOWING MANY HANDS OF PISTILLATE FLOWERS SUBTENDED BY BRACTS, AND LARGE TERMINAL BUD WITH MANY ROUND TIPPED, IMBRICATED BRACTS. **B**, COMPACT, ONLY SLIGHTLY TAPERING BUNCH AND EXTENDED RACHIS WITH RUDIMENTARY OVARIES ON IT. **C**, PLANT IN FOREST SHOWING TALL SLENDER TRUNK, SIX LARGE LEAVES AND EXTENDED RACHIS WITH BRACTS ABOVE. **D**, *TATI'A* GROWING UNDER CULTIVATION AT LOWER END OF VAIHIRIA VALLEY; NOTE EXTENDED RACHIS.

A

B

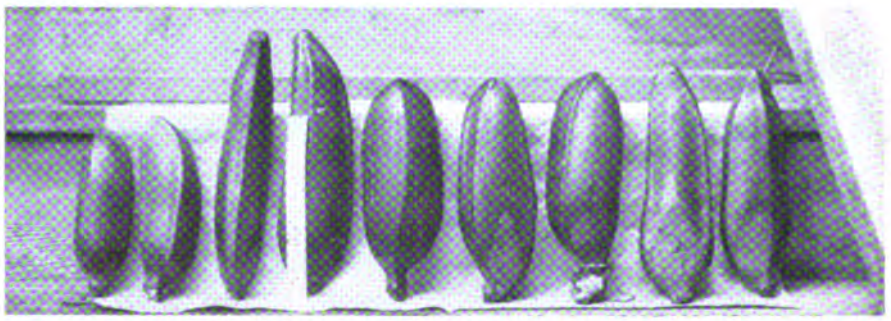
C

D

A, VARIETY *POTI'A:* PLANT SHOWING LONG PEDUNCLE BETWEEN LEAVES AND FRUITS, ALSO TAPERING LEAF BASES. B, VARIETY *POTI'A:* BUNCH OF FRUIT SHOWING ROUND FRUIT ON TIP OF RACHIS; FRUITS IMMATURE, HENCE MORE ANGULAR THAN IS TYPICAL FOR THE VARIETY. C, FE'I BANANA, VARIETY *'AIURI* FOUND GROWING IN MANOA VALLEY, OAHU. D, FE'I BANANA, VARIETY *TATI'A,* GROWING ALONG WAILUA RIVER, KAUAI.

A

B



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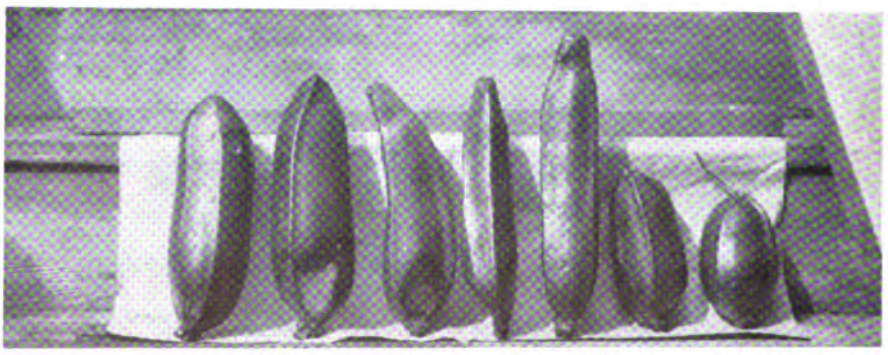

D

A, *PISANG TONGHAT LANGIT*, FROM ISLAND OF AMBOINA; THIS IS WITHOUT REASONABLE DOUBT THE SAME AS THE FE'I OF THE SOCIETY ISLANDS, WHICH IS THE *MUSA TROGLODYTARUM* OF LINNAEUS (PHOTOGRAPH FROM J. C. HAMEL). B, BANANA WITH UPRIGHT INFLORESCENCE FROM THE MOROBE DISTRICT OF NORTHEASTERN NEW GUINEA; APPEARS TO BE A SEEDED FORM OF THE FE'I BANANA (PHOTOGRAPH OBTAINED BY M. S. CLEMENS). C, COMPARISON IN SHAPE AND SIZE OF VARIETIES OF FE'I BANANA: FROM LEFT TO RIGHT, TWO FRUITS OF *'AIURI;* TWO OF *'A'ATA;* TWO OF *RUREVA;* THREE OF *TATI'A* (RULER IS 15 CM. OR 6 INCHES LONG). D, VARIETIES: ONE OF *MAHANI;* ONE OF *TORO AIAI;* TWO OF *'A'ATA;* ONE OF *OEOE;* TWO OF *'U'URURU.*